Light and Lighting

Vol. XLVIII.—No. 10

October, 1955

Published by The Illuminating Engineering Publishing Co., Ltd., on the 1st of each month, at 32, Victoria Street, London, S.W.1. ABBey 7553. Subscription rate 25s. per annum.

CONTENTS

The 47th Session

At this time the Illuminating Engineering Society begins its Forty-seventh Session, and a very active Session it promises to be. Looking at the programme we find there are to be some 125 technical meetings together with a number of social events and a Summer Meeting at Harrogate. At the technical meetings more than 70 different papers, lectures and addresses are to be given covering a wide range of lighting topics. There are to be papers by architects, ophthalmologists and opticians as well as by physicists, engineers and others. The arrangement of such a programme speaks well of the vitality of the Society and its mindfulness of the different interests of its many-sided membership. Like individuals, societies grow old in years although they are not necessarily subject to the decline which their members individually cannot indefinitely escape. Far from declining, the I.E.S. appears to be going from strength to strength, and we see no reason why it should not continue to do so, providing it " moves with the times " adjusting its organisation and activities when necessary to keep it always attuned to the present.

Notes and News

I.E.S. President, 1955-56

As we get older the seasons seem to follow one another more quickly than they did in our youth. The same applies to what are called "sessions"; it seems only a few weeks ago that one I.E.S. session ended, but here we are already announcing the beginning of the next and a new I.E.S. president.

The new president is Mr. A. G. Higgins, who has

A. G. Higgins, I.E.S. President, 1955-56.

served on the I.E.S. Council on many occasions since he joined the Society in 1935 and was a vice-president 1951-53. Educated at Dulwich College, he continued his studies at London University, where he obtained an M.Sc. degree with chemistry as the principal subject. He also studied at the Middle Temple and is a barrister-at-law. He is a Fellow of the I.E.S. and a Fellow of the Royal Institute of Chemistry.

For several years he was with the South Metropolitan Gas Company in the research laboratories and as a works chemist; later he became Outdoor Lighting Superintendent responsible for all the commercial and public gas lighting in the company's area. In 1943 he became assistant secretary of The Institution of Gas Engineers, the appointment he now holds. This is a position which has enabled him to acquire first-hand and detailed experience of the many aspects of the administration of a professional and cultural body—experience which will be of great value to the I.E.S. In 1952 he visited the United States as joint secretary of the Anglo-American Council on Productivity team which made a study of the gas industry in America.

Mr. Higgins has served on many I.E.S. committees and has been particularly interested in education and technical qualifications, both matters on which he has had considerable experience and on which his advice has been of the greatest value to the I.E.S.

We congratulate Mr. Higgins on being appointed president of the I.E.S. and wish him a very successful year of office.

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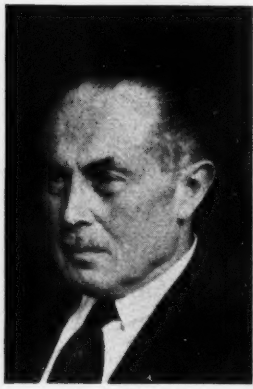
Though presidents change every year, honorary secretaries stay in harness much longer; in fact, since the Society was founded in 1909 there have been only three occupants of that office—Leon Gaster, J. S. Dow, and H. C. Weston. The last-named took office in October, 1946, immediately following his year as president. He had been active in the affairs of the Society for a good many years before that, so that his knowledge of the Society and his advice as a "continuity man" has been of the greatest value to the I.E.S. He believes, however, that it is good to have a change now and then, and once again the Society has taken his advice and a change is to be made; this time the Council has the satisfaction of knowing that the guidance of the retiring honorary secretary is likely to be available to them for a long time and that Mr. Weston's interest in the Society will not diminish. Though independent of his work as



H. C. Weston. *J. G. Holmes.*

honorary secretary, we must also remember Weston's considerable contribution in the shape of the I.E.S. Code, which is based largely on his own fundamental work; he has been chairman of the Code Committee for many years and has been responsible for the improvement in content and presentation which has made the Code so well known and so widely accepted.

Successor to Mr. Weston is Mr. J. G. Holmes,

who is equally well known and who was president in 1951-52. A glass technologist with Chance Bros. at Smethwick, he came to London at the end of the war to join Holophane, Ltd., where he is now technical director. A former chairman of the Birmingham Centre, member of Council and honorary treasurer of the Society, and having served on every standing committee, he is well qualified to take over office. Even though the I.E.S. has a permanent secretariat, the job of honorary secretary is no sinecure—there are plenty of meetings to attend, matters to discuss and policies to be decided. The I.E.S. is without doubt grateful to Mr. Weston for having carried out these duties during the last nine years and wishes Mr. Holmes success in office.

Functional Floodlighting

One of the most pleasant tasks that ever comes the way of the lighting man is a floodlighting job. To Mr. Derek Phillips, who is both an architect and a lighting specialist, has come a particularly interesting floodlighting job—that of designing a scheme for the famous Tivoli Gardens, in Copenhagen, where part of the British Exhibition is now being held. Buildings, some existing and some erected specially, trees and avenues are all lit, but not, let it be noted, in a haphazard manner. Mr. Phillips is concerned with the use of light functionally as well as aesthetically and he has created patterns of light and shade to aid circulation and to help visitors to the fair to find their way about. We look forward to seeing the results and hope to publish details in a later issue.

Invisible Glass

The problem of lighting art galleries so that there are no troublesome reflections from the cover glass is one that has kept lighting engineers and architects at their drawing boards for far too many hours. It need not do so any more. From Switzerland, after 30 years' research by a Swiss inventor, comes "Reflo" glass—a true glass, not a plastic—which gives virtually no reflections of surrounding objects. Pictures covered with this glass can be seen at the Marlborough Galleries, Old Bond Street.

Dow Prize Competition

Previous Dow Prize Competitions have endeavoured to encourage collaboration between students of illuminating engineering and students in other fields in which lighting plays an important part. It is thought that the time is now ripe for a competition which would call for individual, rather than co-operative, effort and which would attract entries from practising or student lighting engineers, who constitute an ever-increasing section of the membership of the Illuminating Engineering Society.

The I.E.S. has decided, therefore, to hold a Dow Prize Competition involving the submission of essays in which the entrants will have the opportunity of discussing their individual approach to lighting engineering and to put forward their own ideas as to the scope and methods of the lighting engineer, supported by examples of their own work or of current lighting practice. The title of the essay will be :—

How I Look at Lighting Engineering.

It is hoped that such a competition will not only create interest in itself, but will furnish the Society with the stimulus of fresh thinking and help to bring to the fore members of the Society who hitherto have been debarred, either by diffidence or lack of opportunity, from making their views felt. It is also hoped that the competition will create an increased sense of the importance of the rank-and-file lighting engineer, whose work tends, by the nature of things, to receive less prominence than does the more spectacular or academic work.

Three prizes will be awarded to the value of 25 guineas, 15 guineas and 10 guineas, and other meritorious entries will receive commendations. Winning essays will also be considered for presentation at a meeting of the Society, or for publication in *Light and Lighting*.

Conditions of Entry

1. The competition is open to any member of the Illuminating Engineering Society.
2. Entries shall be in the form of an essay on the subject "How I Look at Lighting Engineering." Essays will be judged on the views expressed and on the way they are expressed. Opinions supported by factual examples will carry more weight than opinions supported only by argument. Opinions alone will carry little weight. Hypothetical examples are not ruled out.
3. The views expressed shall be the competitor's own views, except where reference to those of others is essential to the argument.
4. Essays should be about 3,000 to 5,000 words in length. Three copies of each essay are required, typed in double spacing on one side of the paper only. Photographs, sketches, etc., which accompany the essay must be clear and descriptive and be adequately captioned.
5. The entrant's name must not appear anywhere on the manuscript, but must be given on a separate sheet attached to the three copies of the manuscript.
6. Entries must be sent to The Secretary (Dow Prize Competition), The Illuminating Engineering Society, 32, Victoria Street, London, S.W.1.
7. The last date for submission of entries is February 29, 1956.
8. In the event of there being no entry of sufficient merit no prizes will be awarded.
9. The competition will be judged by a panel of assessors appointed by the Illuminating Engineering Society. The assessors' judgment of the entries shall be final. In all other matters relating to the competition the decision of the Council of the I.E.S. shall be final.

Entrance hall to the new examination halls of Edinburgh University.

Two New L.C.C. Schools

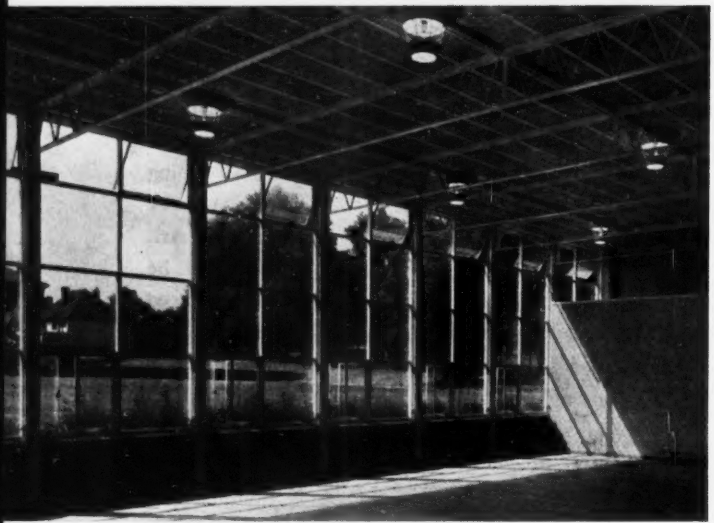
School in Tulse Hill, Lambeth: architects, Yorke, Rosenberg and Mardall, F./F./F.R.I.B.A.,; architect in charge, T. R. Evans, A.R.I.B.A.; assistant architect, R. R. Tomalin, A.R.I.B.A.; consulting engineers, Clarke, Nicholls and Marcel; mechanical, heating and electrical consultants, Oscar Faber and Partners.

Main entrance to the Dick Sheppard School, with access bridge on right.

School in Woodham Road, Lewisham: architect, J. L. Martin, M.A., Ph.D., F.R.I.B.A. (architect to the L.C.C.); schools architect, S. Howard, L.R.I.B.A.; assistant schools architect, G. F. Horsfall, M.B.E., B.Arch., A.R.I.B.A.; architect in charge, W. J. Smith, A.R.I.B.A.; electrical installation specification prepared and work supervised under direction of J. Rawlinson, M.Eng., M.I.C.E., M.I.Mech.E., M.I.Mun.E. (chief engineer and county surveyor to the L.C.C.).

Two London County Council schools for girls were opened recently—one in Tulse Hill, Lambeth, one in Woodham Road, Lewisham. The first, to be known as the Dick Sheppard school, will cater for about 960 girls between the ages of 11 and 16. In addition to preparing them for the General Certificate of Education, special emphasis will be given to music and art and to commercial studies. There are well-equipped typing and commercial rooms, and a model office where the older girls will be able to practise office routine. Art, including pottery, fabric printing and modelling, will be correlated with fashion drawing and design for advanced dressmaking and millinery studies. There will also be a pre-nursing course forming part of a wider course designed to lead to a variety of occupations linked with the medical services. The Dick Sheppard school took nearly three years to build; it cost just over £300,000, including its equipment. The second new school will be known as the Catford County school; it will provide secondary schooling for 1,200 girls. There will be a general course, including mathematics and French, for the first two years, followed by a further two or three years during which some girls, in addition to studying general subjects, will receive specialised tuition in housecraft, needlework, arts and crafts and science, while others will be able to take three-year courses in commerce or dressmaking. The General Certificate of Education and alternative external examinations will be taken at the end of the fifth year. The Catford County school has taken nearly three years to build at a cost, including furniture and equipment, of approximately £350,000.

The Dick Sheppard school: Left, view through corridor between servery (left) and dining/classrooms. Dome lights conceal tungsten lamps; wall lights, as used throughout for corridors and staircases, have spun metal reflectors. Below left, gymnasium: note special fittings, comprising wire cage, spun metal bands top and bottom and wire guard at base, hinged for access.



THE DICK SHEPPARD SCHOOL

The site for the Dick Sheppard school is five acres in extent; it slopes over 30 ft. from south to north and is mostly below the level of the main road. Because of this, the main access is across a bridge leading to an entrance hall at first floor level, and most of the circulation is kept at this level throughout the various parts of the school.

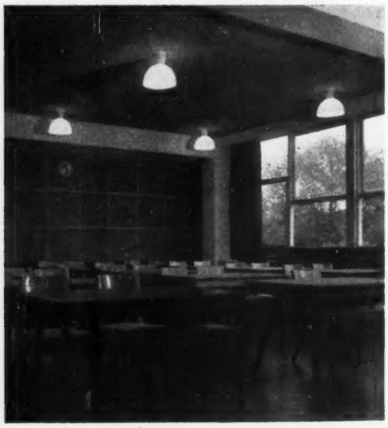
There are five distinct elements to the plan: the teaching block, the assembly hall and entrance, the administrative block, two gymnasia with their changing rooms, and the kitchen and dining/classrooms. The classroom block has four floors, the maximum permitted without lifts (although with circulation at first floor level this amounts to " three up, one down "). There are four projecting wings.

The administrative block links the entrance hall and the classroom block; its first floor comprises circulation space and serves also as the cloakroom; its two upper floors contain staff rooms, offices and the medical suite.

The assembly and entrance halls are planned so that they can be used as one to seat 1,000; at other times they are divided by a curtain. A double row of classrooms, divided from each other and from a central corridor by sliding/folding partitions, act as the dining hall at lunch time. The servery is adjacent; the kitchen below.

Construction

Most of the school, including the four-storey classroom block, has reinforced concrete framing, with brick in-filling panels between the columns. Floors and roof slabs are of hollow tile construction, precast concrete facing units being used as permanent shuttering to the exposed edges of the slabs. The assembly hall has portal frames of precast concrete units spanning 50 ft.; the kitchen block and the gymnasia have light steel lattice frames. These three blocks all have roofs of three-inch woodwool slabs, covered with built-up felt



Typical classroom: standard L.C.C. school luminaires, with 14-in. diam. plastic dispersive shades give 12 lm/ft^2; chalkboards have strip lighting.

roofing. The bridge leading to the main entrance is of cantilever construction, also in reinforced concrete.

Heating plant comprises two cast-iron sectional boilers, oil fired and automatically controlled. There are both indoor and outdoor thermostats. Classrooms and most other areas are heated by convectors concealed beneath the windows; elsewhere radiators are used, while heated pipe coils incorporated in the hat and coat fittings heat the cloakroom.

Lighting

The architects made a point of avoiding " double-banking " the classrooms; most of them have windows

on both sides and, where this was not possible, there is clear-storey lighting opposite the main windows. The daylighting factors achieved were checked by the B.R.S. protractor method, and found to be above the minimum standards laid down by the Ministry of Education.

In the art rooms and geography room situated on the top floor, toplighting has been used; tungsten lamps being incorporated in the dome lights so that artificial lighting, when required, comes from the same direction as the natural light.

There is full stage-lighting equipment, including two "front-of-house" spots suspended from the main structural frame of the hall. The switchboard and dimmer switches are in a box adjacent to the stage. The chandeliers in the assembly hall and main entrance hall are "specials." The upper halves of the shades house lamps connected to the emergency supply.

The luminaries used in the gymnasia, with their protective wire cages, are a standard manufacturer's line, slightly modified with respect to the fixing.

The Installation

Electrical services comprise lighting, single-phase power (13 amp. socket outlets), three-phase power, and power for electrical cooking. The installed load is approximately 1,300 kVA. and the estimated demand 595 kVA.

The supply is distributed from the main switchroom via four switchboards—one for each of the four installations listed above—and two sub-switchboards located in the classroom block. The main distribution is carried out in P.I.AL.C. cable run in ducts and false ceilings. Sub-circuit wiring, mostly concealed, is in conduit and V.R.I. cable.

There is a combined broadcast system for two-channel school broadcasts, class changing signals, a public address system and fire alarm signals. The system is arranged so that priority signals (fire alarms have the highest priority) over-ride all other signals. The class changing signals are impulsed by a master clock, which also controls all other clocks in the school.

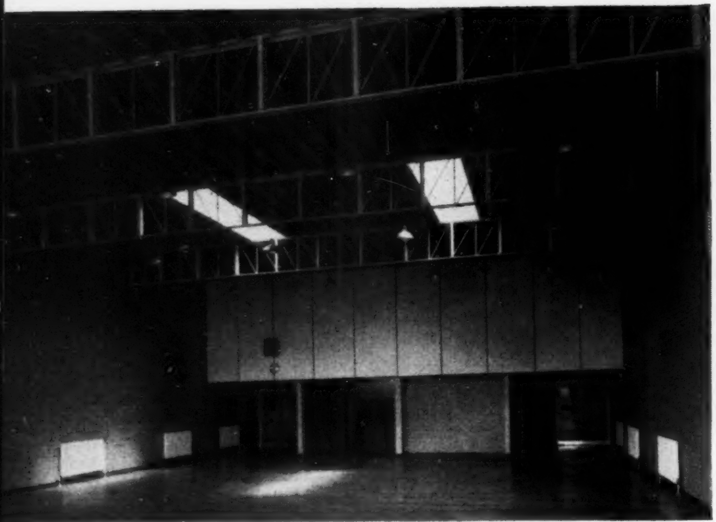
Secondary lighting is provided for the assembly hall from a floating battery, which also supplies current to the broadcast system for fire alarm signals.

THE CATFORD COUNTY SCHOOL

The site of the Catford County school is rectangular in shape, five acres in extent and, apart from one level area at the south-east end, slopes steeply towards the west. There are two main blocks, joined by a single-storey link block containing rooms for the headmistress and the deputy-headmistress, and offices for the administrative staff.

One main block, four storeys high and sited on the level part of the site, contains most of the teaching accommodation, together with the staff rooms and a

Dick Sheppard school: Assembly hall, looking towards stage. The chandeliers each comprise six diabolo-shaped units, the top halves of which house lamps connected to the emergency supply. Top right, general view of school, from east.



Catford County school. Left, gymnasium; standard school luminaires are sufficiently high (16 ft.) not to cause glare nor to be damaged during ball games. Below left, pottery room; seen behind glazed partition is 12-kw. kiln.

medical inspection suite (on the ground floor). There are two rows of classrooms on each floor, with a central corridor lit from the glazed staircase wells and open cloakroom areas.

The other main block, on the sloping part of the site, contains the assembly/dining hall at ground floor level, the gymnasium at a much lower level, changing rooms and lavatories at mezzanine level, and the boiler room and fuel store under the assembly hall. The assembly/dining hall has a central ramped "well," covered by fixed seating, and three classrooms on either side. These are separated from the hall by continuous demountable screens, and separated from each other by sliding/folding partitions.

Construction

The school was planned and constructed on a 3 ft. 4 in. grid. The main teaching block has a prefabricated light steel frame similar to that used by the Ministry of Education for its experimental school at Wokingham. Perimeter stanchions and main floor and roof beams are at 13 ft. 4 in. centres, and secondary beams at 3 ft. 4 in. centres carry precast concrete floor slabs, replaced at roof level by $2\frac{1}{2}$-in. woodwool slabs.

Cladding is mainly of glass curtain walling placed 8 in. proud of the perimeter grid lines. Solid cladding panels, where used, are half storey height (5 ft. 8 in.) by 1 ft. 8 in. wide. They are made of precast concrete faced with Hopton Wood stone aggregate ground to a smooth finish.

Other blocks are similarly constructed, except the gymnasium, which has walls of load-bearing brickwork supporting main steel beams at 13 ft. 4 in. centres. These, in turn, carry a concrete T-beam roof.

The box-section stanchions are protected against fire by precast vermiculite concrete casing; internal floor and roof beams are protected by suspended ceilings of vermiculite slabs. "Back-up" walls behind the curtain walling between floor and sill level are of 3-in. woodwool slabs, rendered externally and plastered internally. Partitions are mostly of precast hollow gypsum panels, storey height, 2 ft. wide and 3 in. thick.

Heating is by low-pressure hot water from oil-fired boilers. There are pipe coils in corridors, fan-operated convectors in the assembly hall and hospital-type radiators elsewhere.

Staircase to gymnasia; top lighting, as throughout, has egg-crate laylight, to prevent glare.

Lighting

In spite of the large areas of wall glazing a considerable proportion of top lighting has been used. In lecture rooms, top lighting replaces wall glazing to give an even distribution of light and to avoid glare; in the art and weaving rooms there is top lighting in addition to the wall glazing, in order to ensure high lighting factors;

Catford County school. Staircase in teaching block: small box on wall houses microphone for intercom system; below it is fire alarm push. Bottom of page, teaching block, seen from north, with link block on right.

and in the dining rooms, changing rooms and gymnasia, supplementary top lights help to maintain the required illumination levels over the large floor areas.

Classrooms, all other teaching rooms (except the art rooms), and the gymnasia are lit by tungsten lamps in standard L.C.C. school luminaires with 14-in. diameter plastic dispersive reflectors. A typical classroom has nine of these fittings each containing a 150-watt lamp. Another standard L.C.C. fitting, housing four 60-watt lamps, illuminates the chalkboard. The illumination level in normal teaching rooms is approximately 12 lm/ft^2. In art and needlework rooms, fluorescent fittings, each holding one 40-watt "warm-white" lamp and one 40-watt "colour-matching" lamp, are used to provide 20 lm/ft^2.

In the assembly hall cold cathode lighting has been used, the 48 8-ft. 6-in. tubes being arranged on the ceiling to form a decorative pattern and to provide approximately 8 lm/ft^2. Cold cathode lighting was chosen for economy in electricity consumption and to minimise the frequency at which replacements will have to be made (the ceiling height is 25 ft.).

The Installation

The main switchboard and the kitchen control panel are of the cubicle pattern; fuses here and on the distribution boards being of the H.R.C. type. Distribution is via P.I.L.C. and S. cable and mineral-insulated, copper-sheathed cable (for outdoor lighting), while sub-circuit wiring is in V.R.I. cable in H.G. welded screwed conduit.

There are two BS 1363 socket outlets in each classroom and a 2-kw. reflector fire or panel heater in each staff room, and the housecraft rooms have numerous socket outlets for connections to household appliances such as refrigerators, electric irons and washing machines. In the science laboratories there are low-voltage terminal units fixed to the benches, giving 0—18 v. A.C. and D.C. for experiments, the current being supplied by a special power unit designed by the L.C.C. Chief Engineer's department.

All equipment in the school kitchen is electrically operated; the total load is 200 kw. Stage lighting is provided, a dimmer control board being situated in a "fly" gallery. Power circuits in the boiler house (the boilers are oil-fired) serve the circulating pumps, the fire booster pumps and a fuel pump.

THE FIRMS CONCERNED

School in Tulse Hill, Lambeth: general contractors, Rush & Tompkins, Ltd.; electrical services, Read & Partners, Ltd.; switchboards, Varilectric, Ltd.; distribution boards, Artic Fuse & Electrical Manufacturing Co., Ltd.; broadcast system, Clarke & Smith Manufacturing Co., Ltd.; lighting fittings, Falk Stadelmann & Co., Ltd., S.L.R. Electric, Ltd.; Troughton & Young, Ltd.; stage lighting, W. J. Furse & Co. (London), Ltd.; dome roof lights, Pilkington Brothers, Ltd.

School in Woodham Road, Lewisham: general contractors, Thomas & Edge, Ltd.; electrical installation, Berkeley Electrical Engineering Co., Ltd.; main switchboard, kitchen control panel and distribution boards, Artic Fuse & Electrical Manufacturing Co., Ltd.; boiler house control panel, The Rheostatic Co., Ltd.; stage lighting switchboard, Strand Electric & Engineering Co., Ltd.; stage lighting equipment, Major Equipment Co., Ltd.; cold cathode fittings in assembly hall, Courtney Pope (Electrical), Ltd.; cold cathode tubes, General Electric Co., Ltd.; broadcast equipment and internal communications equipment, Clarke & Smith Manufacturing Co., Ltd.

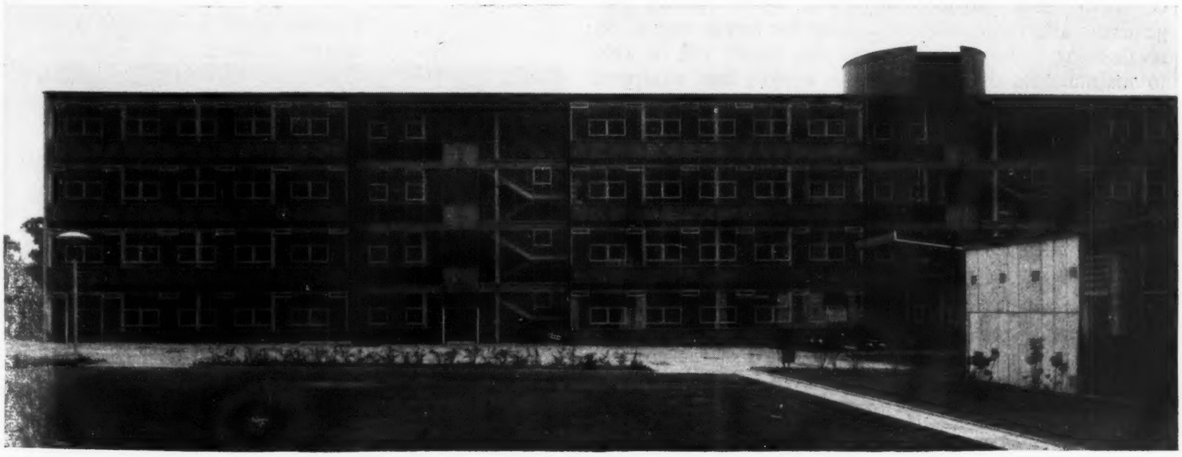


Fig. 1. *Instrument runway and approach lighting.*

Operational Lighting at Jan Smuts Airport

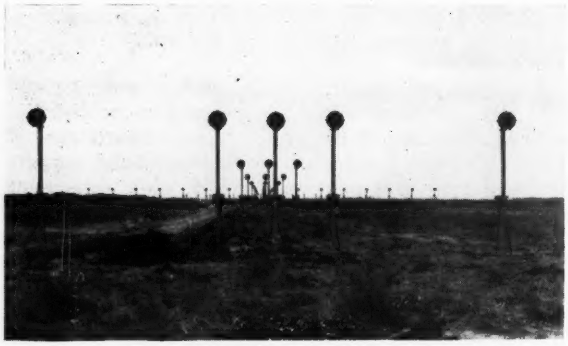


Fig. 2. *Approach lighting viewed along centre line.*

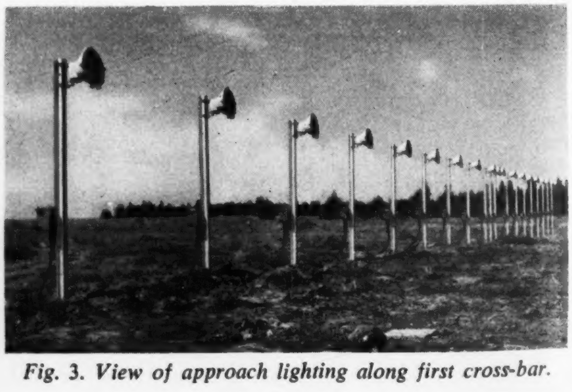


Fig. 3. *View of approach lighting along first cross-bar.*

The tremendous growth of civil aviation in recent years, with its possibilities for improved trade and social intercourse between nations, means that the advent of an addition to the number of first-class international airports is a significant event; this was undoubtedly the case when, on September 1, 1953, the magnificent new Jan Smuts Airport, Johannesburg, came into full use.

As an airport of this type must be " always complete but never finished," it is vitally important that the planning authority should be far-sighted, and the South African Railways, who at the time were responsible for the main civil airports in the Union, showed this attribute to a remarkable degree, certainly in regard to the electrical equipment of Jan Smuts Airport. The airport lighting system in particular has been planned to provide facilities equal to those provided anywhere in the world, and generous allowance has been made for future expansion so that for many years to come Jan Smuts will be able to maintain its place among the world's best equipped airports.

There are at present three runways, one of which (03-21) is 10,500 ft. long and is selected for instrument landings in conditions of bad visibility, I.L.S. equipment being provided for the initial approach. To supplement this and to give the pilot the necessary guidance during the final run-in, a Calvert Line-and-Bar high intensity approach light system has been installed. This system, originated by Calvert of R.A.E. Farnborough and now adopted as a standard by I.C.A.O., is designed to keep the pilot fully and continuously informed of the position and attitude of his aircraft in space even in weather conditions in which both the ground and the horizon are invisible.

Approach Lights

The approach light system at Jan Smuts consists of a line of high intensity uni-directional lights spaced at 100 ft. along the extended centre line of the runway for a distance of 3,000 ft. from the threshold. The line is divided into three equal parts, that farthest from the runway having three lights, the centre portion two lights and the nearest portion one light at each position, thus giving an approximate indication of distance from the threshold. Six cross-bars composed of similar high intensity lights are equally spaced along the centre line, the main function of these being to act as an artificial horizon. As seen by an approaching pilot, the bars decrease progressively in length and are so arranged that the correct rate of descent or "glide angle" is maintained if each bar appears the same length as it passes out of the pilot's view beneath the aircraft.

The provision of as many as six cross-bars may appear unduly generous, but it should be realised that the object of the Calvert system is to ensure that, in bad visibility conditions, once the pilot has changed from instrument to visual flying technique, he can at all times see at least one artificial horizon bar in addition to a sufficient number of centre-line lights to indicate the correct approach line. With modern aircraft there is no time for the mental re-adjustment necessary to revert to instrument flying after the change over has been made.

The approach light fittings, of which there are 128 installed, each employ a 250-watt Class B.1 projector lamp in conjunction with an anodised aluminium reflector of special contour. The centre-line lights are fitted with a clear front glass, the light distribution being in the form of a symmetrical beam of notably "flat top" characteristic, with a maximum intensity of 80,000 cd. and a divergence of 14 deg. to one-tenth maximum. The cross-bar lights are fitted with spreader glasses and give a maximum intensity of 30,000 cd. with a divergence of 30 deg. in azimuth, the object being to ensure as far as possible that the system will be visible to an approaching pilot in bad weather even if there is some lateral error in the radio navigation. To cater for variable visibility conditions, the whole approach light system is equipped with intensity control, seven steps being provided, namely, 100, 30, 10, 3, 1, 0.3 and 0.1 per cent. of the maximum.

Runways

There are two types of runway lights installed, the instrument runway and also the second runway (09-27, 8,250 ft. long) being equipped with elevated three-element combined high-and-low intensity fittings spaced at 200 ft. intervals. In these, the two high intensity elements consist of anodised aluminium paraboloidal reflectors with spreader glasses which, in conjunction with 6-volt 36-watt automobile type lamps, give a maximum intensity of 33,000 cd. with a beam divergence in azimuth of 17 deg. They are arranged to face in opposite directions along the runway and are independently adjustable in both vertical and azimuth planes. They are normally set with the beam axis at an angle of elevation of approximately 3 deg. above the horizontal, and are inclined in azimuth towards the centre line of the runway, so that the maximum intensity is directed towards the point of optimum visibility range in bad weather. The third, low intensity, element consists of a prismatic glass dome, giving a symmetric light distribution with a maximum intensity of approximately 130 cd. at an elevation of 3-4 deg. above the horizontal. The lamp used is similar to that in the high intensity elements.

All three optical systems, which are on separate series circuits, are incorporated in a cast aluminium-alloy housing which is provided with a ball joint for ease of levelling. The fitting is mounted on a cast-iron underground chamber containing the series isolating transformers, and the point of mounting embodies a special frangible plate and an automatic disconnecting plug, so that in the event of collision by an aircraft damage to both aircraft and fitting is reduced to a minimum, while risk of subsequent fire is largely avoided since all three circuits are automatically disconnected as soon as the mounting plate is broken.

There are in all 199 runway lights installed on the

Fig. 4. View across Runway No. 1 showing an elevated runway fitting.

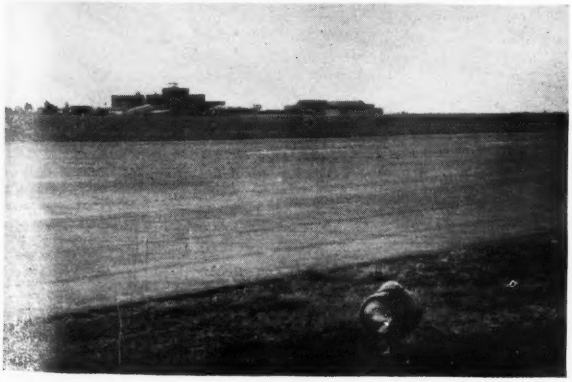


Fig. 5. Elevated high and low intensity runway light.

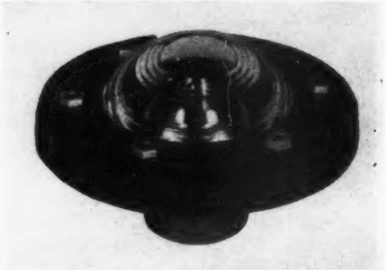


Fig. 6. View across apron showing flush type taxi-track light.

Fig. 7 (above). Flush type low intensity taxiway light.

two runways, including six green threshold lights across each end, these being identical with the runway lights except that a clear glass is provided in place of the spreader in the high intensity elements to compensate for the loss by absorption in the green glass filters. The low intensity elements are fitted with internal directional refractors to serve the same purpose.

As in the case of the approach lights, the runway light circuits are provided with seven stages of intensity control, but differently arranged, to give 100, 30, 10, 3 and 1 per cent. maximum for the high intensity elements, and 100 per cent. and 30 per cent. for the low intensity. In addition, provision has been made for the low intensity element to be used at 100 per cent. if required, in conjunction with any stage of the high intensity lights.

The third runway (15-33), which is also 8,250 ft. long, is equipped with low intensity flush-type lights at 200 ft. intervals, the optical systems being identical with those of the corresponding elements of the elevated lights. In this case the isolating transformers are housed in separate cast-iron boxes.

The design and layout of the approach and runway lighting systems on the instrument runway are such that, in conjunction with the I.L.S., approaches and landings may be made in conditions down to 220 yd. daylight met. visibility range.

Taxiways

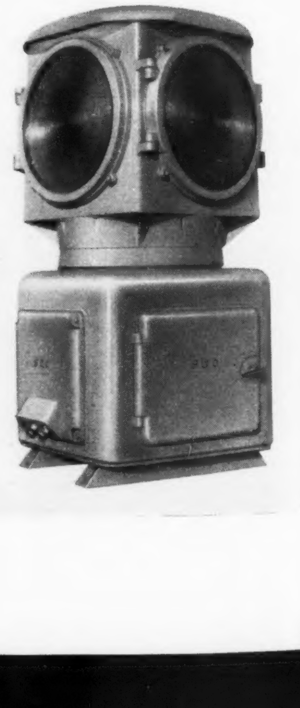
A first-class runway and approach system can only be used to full advantage if the associated taxiways are laid out to allow free movement of aircraft at all times to and from the runway; Jan Smuts Airport is well served in this respect, the taxiway lighting in particular being planned to ensure that landings and take-offs are interrupted as little as possible by taxying operations. The taxiways are equipped with flush-type low intensity lights on both sides, at a spacing of 120 ft. on straight runs, while on bends and at junctions the spacing is reduced to improve route definition. The fittings and lamps are the same as those used for low intensity runway lighting but are provided with blue glass colour screens. A total of 427 fittings are installed, covering not only the tracks serving the runways and the aircraft maintenance area but also marking the outer edge of the passenger loading apron.

To avoid confusion of traffic and to make it as easy as possible for a pilot to follow the correct route, the taxiway lighting is divided into 12 sections on separate circuits, so that the Control Officer can select and illuminate only the desired sections for any particular movement.

An important feature of the ground lighting equipment is that all the runway and taxiway lights employ the same lamps, which simplifies maintenance and the provision of spares.

The runway lights are operated on the majority of occasions at one of the lower stages of intensity control, while, in the case of the taxiway lights, since the intensity available is more than sufficient, the circuits are arranged to operate at slightly below the current rating of the lamps. This ensures economical lamp life without sacrifice of the optical advantages of relatively high efficiency lamps.

Fig. 8. Airport location beacon.



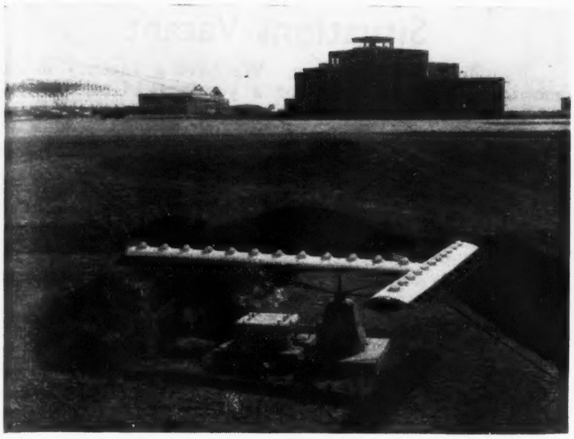


Fig. 9. Illuminated landing direction indicator.

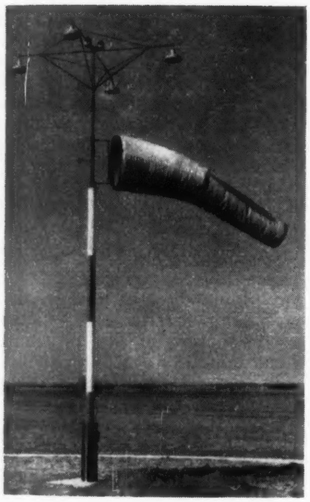


Fig. 10. Illuminated wind sleeve.

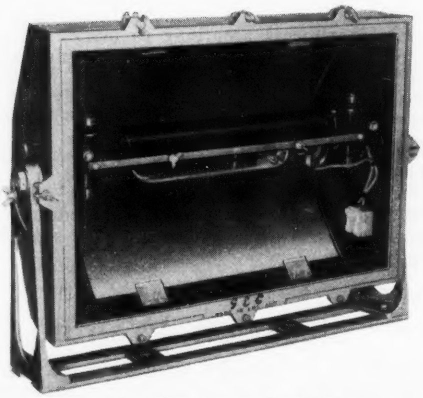


Fig. 11. 1-kw apron floodlight.

Auxiliary Equipment

The essential auxiliary lighting equipment installed includes an airport location beacon, illuminated landing direction indicator, illuminated wind sleeve, cloud height projector, apron floodlights and obstruction lights.

The location beacon, which is mounted at the top of one of the hangars, is of the four-aspect rotating type, in which the optical system consists of four 20-in. diameter prismatic glass lenses symmetrically disposed round a special 100-volt $2\frac{1}{4}$ kw. lamp. The lantern is rotated to give 12 flashes per minute at all angles in azimuth, the time-intensity integral of each flash being 110,000 candela-seconds (white). Two of the lenses are equipped with internal green colour filters, so that the signal consists of alternate white and green flashes. An automatic gravity operated lamp-changer is incorporated, controlled by a series relay, which, on the failure of a lamp, brings a second lamp to the focal position and at the same time operates an alarm.

The landing direction indicator is in the form of a Tee which may be rotated by a remotely-controlled motor enclosed in the base, the degree of movement being limited by pre-set micro switches to correspond with the directions of the runways, so that operation of the control switch moves the indicator to a pre-selected landing direction. Accurate direction indication is ensured by an automatic magnetic brake on the rotating mechanism. For use at night, the upper surface of the Tee is equipped with 15-watt lamps under weatherproof "Perspex" covers spaced 1 ft. apart. Associated with the L.D.I. is the wind direction indicator which consists of a standard fabric sleeve mounted on ball bearings on a steel mast and illuminated from above by four 150-watt lamps in vitreous enamelled reflectors.

The cloud height projector for the visual observation

Fig. 12. Lighting control console.

of cloud height at night employs a long focus paraboloidal reflector with a 24-volt 500-watt concentrated filament lamp to project a vertical beam of very small divergence. The cloud height is read directly from the scale of an inclinometer graduated in feet on a fixed base of 1,000 ft.

Floodlights are installed on the loading and maintenance aprons to facilitate movement of aircraft at night. The floodlights must not interfere with the movement of aircraft on runways or taxiways, and the light distribution of the fittings must therefore be closely controlled. The floodlights used, of which 26 are installed, employ 1,000-watt horizontal line filament tubular projector lamps in conjunction with parabolic trough silvered glass reflectors of high accuracy. The resultant light distribution is in the form of a fan-shaped beam having a maximum intensity of 100,000 cd. and a divergence in azimuth of approximately 100 deg., while the vertical divergence is very small and the intensity at angles above the beam axis falls off very rapidly. To ensure even illumination of the aprons, certain of the floodlights are provided with a special system of vertical spreader glasses affecting only the lower half of the beam.

The obstruction lights are of the standard duplex type, each consisting of two 75-watt lamps under separate red prismatic glass domes. Comparatively few are required on a modern well-equipped airport, the movements of aircraft on and in the vicinity of which are closely controlled by runway, taxiway and approach lights.

Control

The control of all the lighting equipment at Jan Smuts is from a console-type panel in the control tower. Besides the necessary switches for all lighting circuits and a mimic diagram of the airport which shows by back-indication which circuits are in use, the panel incorporates the intensity controls and a master direction selector which governs the approach, runway, taxiway and L.D.I. services which are dependent on the runway in use and direction of landing and take-off at any time. For speed of operation the complete preferred taxiway route for either landing or take-off can be controlled by a single switch, but individual overriding control is provided for each section of taxiway in case of emergency.

The whole of the control gear and sub-station switchgear has been planned for possible expansion—for instance, provision has been made for the installation of approach lights on runway 09-27, which, as has been mentioned, is already equipped with high intensity runway lights. Safety in emergency has also been carefully considered, an example being the provision of an automatic starting stand-by Diesel generator set, which can furnish upwards of 200 kw. within 30 seconds of the failure of the two separate municipal supplies which are permanently connected.

Acknowledgments

All the lighting equipment was supplied by the General Electric Co., Ltd., and installed by the General Electric Co. (Pty.) Ltd. of Johannesburg in co-operation with South African Railways. Acknowledgment is made to South African Railways for permission to use Figs. 1, 2, 3, 4, 6, 9, 10 and 12, and to the G.E.C. Ltd. for the remaining illustrations.

Lighting Abstracts

OPTICS AND PHOTOMETRY

209. The layman's use of glare factors. 612.843.367
R. D. BRADLEY, *Illum. Engng.*, **50**, 213-216 (*May*, 1955).
Describes by means of examples ways in which the degree of discomfort glare produced by a lighting installation can be assessed from data presented in tabular form. The tables include those used in the Harrison-Meaker Glare Factor System, the Meaker-Oetting Visual Comfort Index System, and the Logan-Lange Visual Comfort Factor System. The Moon-Spencer Interflection System is also briefly referred to. P. P.

210. Cosine-corrected illumination photometer. 535.24
F. HARTIG AND H. J. HELWIG, *Lichttechnik*, **7**, 181-182 (*May*, 1955). *In German.*
The photo-voltaic cell of an illumination photometer, with or without a colour correcting filter, is covered with an opal glass dome and this is surrounded with a dished ring of specially designed section. The upper surface of the ring is so shaped that the photo-current is proportional to the illumination within about $\pm$ 2 per cent. for all angles of incidence up to 85 deg. or over. The sensitivity is stated to be 0.6×10^{-6} amp per lux. J. W. T. W.

LAMPS AND FITTINGS

211. A study of high intensity light sources. 621.32
S. M. SEGAL, *Illum. Engng.*, **50**, 259-262 (*May*, 1955).
Comparisons are made between the actual source sizes, the spectral distributions, the peak luminances and the relative infra-red components of a number of light sources used in searchlights and other high-intensity projectors. These light sources include a 3-kw. tungsten filament lamp, various carbon arcs, a 1-kw. xenon arc and two high-intensity mercury vapour arcs. Some comments on relative costs are given. The determination of the photometric data is described in some detail. P. P.

621.329 : 628.971.6
212. Street lighting fittings, with an oblique light distribution, for wall mounting.
H. WINKLER, *Lichttechnik*, **7**, 175-176 (*May*, 1955). *In German.*
Describes a trough street lighting reflector, with two 4-ft. 40-watt fluorescent lamps, giving a polar curve, at right angles to the reflector axis, with a maximum of about 30 deg. from the downward vertical. The reflector is intended for wall-mounting and can be tilted to bring the maximum intensity to any desired angle. A particular installation in a rather narrow thoroughfare (24 ft.) is illustrated. The mounting height is 20 ft. and the spacing 80 ft. Dangerous glare is avoided and the brightness distribution is satisfactory. There are no posts or overhead cables, maintenance is simple and costs of installation and upkeep are low. J. W. T. W.

621.327.4
213. The mercury vapour lamp as a circuit component.
H. O. ROST, *Illum. Engng.*, **50**, 302-306 (*June*, 1955).
The mercury vapour lamp is shown to possess extremely complex circuit characteristics varying with the ignition of the arc, the stabilisation period, the starting period, the operating phase and the extinguishing period. The conflicting requirements produced by these characteristics are discussed in relation to the proper design of both the ballast and the lamp. P. P.

621.329 : 628.971.6
214. New investigation of the lighting characteristics of street lighting fittings for fluorescent lamps.
A. PAHL, *Lichttechnik*, **7**, 177-181 (*May*, 1955). *In German.*
The author has made an extensive series of measurements of luminous flux from different types of fittings operating under a range of conditions, particularly as regards ambient temperature. The fittings were mounted in a box with temperature control and this box acted as a photometric integrator. A series of curves of light output over a wide range of temperature is given; these refer both to ambient and to the temperature of the wall of the lamp. A series of correction factors for adjusting measurements made at different ambient temperatures is given. This work is of importance in street lighting design, particularly in regard to measurements made to check the performance of a system. J. W. T. W.

LIGHTING

215. Appraisement of public lighting. 628.971.6
R. WALTHERT, *Bull. Assoc. Suisse Elect.*, **46**, 473-476 and 485 (*May* 14, 1955). *In German.*
This, mainly descriptive, paper deals with the objectives of street lighting which are broadly summed up in the requirement that it should enable the driver to proceed rapidly and safely without headlights. The various points made are illustrated with sketches of idealised situations. J. W. T. W.

628.93
216. Brightness and illumination by interreflections in enclosures.
R. S. WISEMAN, *Illum. Engng.*, **50**, 227-255 (*May*, 1955).
Equations have been developed giving the working plane illumination and the initial and final illuminations and luminances of the surfaces in a room in which the source of light is one or other of the surfaces themselves. The theoretically derived values so obtained are compared with measurements in a model room, the photometric techniques employed being described in detail. The agreement is sufficiently good for most purposes. For more exacting requirements a series of "correction factors" have been developed which are applied to the theoretical equations and reduce the variations between calculated and measured values to within 5 per cent. P. P.

628.97
217. Fluorescent stage lighting for school auditoriums.
W. TAO, *Illum. Engng.*, **50**, 221-224 (*May*, 1955).
The advantages in terms of higher efficiencies and lower operating temperatures of using coloured fluorescent lamps in preference to filtered incandescent lamps for stage lighting are discussed. Some suggestions are given for the equipment required to light a school stage by fluorescent lighting. P. P.

Handleys Store, Southsea

Architects: Healing and Overbury (of Cheltenham)

Main contractors for building: James Longley

Consulting engineer: A. W. Jervis (Debenhams, Ltd.)

Electrical contractors: T. Clarke and Co., Ltd.

The recently completed store for Handleys, Ltd., at Southsea, has many points of interest to the architect, lighting engineer, and electrical engineer. The premises stand on a site of 40,000 sq. ft. with frontages on three roads. The cubic capacity of the store is 1,860,000 cu. ft.

Electricity Supply

Power supply is taken from the mains of the Southern Electricity Board via a sub-station (2—500 kva. transformers with room for extension) at the rear of the building. From the sub-station a supply is taken to a cubicle type switchboard in the basement where the remote control panels for two diesel generators used for emergency supplies are also installed. Normal distribution, using P.I.L.C. cables, supplies fuseboards throughout the building.

Switching

For the control of showroom lighting an early problem was the position and method of switching, a problem common to all large area showrooms. After consideration of various methods it was decided to have the switches for the whole floor in one unit away from the showroom, the actual position being determined to a certain extent by the space required to accommodate the gear.

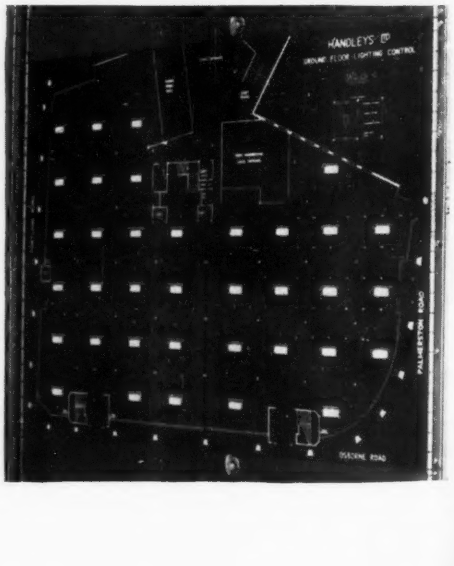
A method of locating the switches in reference to the points controlled was devised. Each switchpanel is engraved with a plan of the floor and the switches located in the panel in the same position as the lights they control. Each switch has a coloured dot above it corresponding to a colour code engraved on the panel.

On the first floor the lighting layout is not on a fixed system but is liable to variation. It was not possible, therefore, to use the same fixed switching arrangement as on the ground floor. The switches were therefore placed on the panel in a rough approximation to the area they controlled; over this was mounted a sheet of "Perspex" on which was painted (in reverse) the floor plan of the lighting fittings with lines from the fittings to the appropriate switches. Should it become necessary to alter the switching it will be a simple job to alter the plan.

Wiring

With all the controls sited in one place the amount of wiring is considerable. To reduce the number of connections that had to be made on site, the ground-floor panel, comprising incoming cables, isolation fuses and switches, was built as a three-sided unit and interconnected in the factory. From this unit cables were taken to special floor-connecting boxes located in the centre of each main structural bay. These boxes have access (via floor traps) from the showroom above and go through the concrete floor to the ceiling void; a detachable bottom plate allows access to this void from the floor above. From these boxes conduits are run to the individual lighting fittings or floor plugs, one circuit in each box being allocated to pilot or emergency lighting.

Ground floor control panel.



Lighting

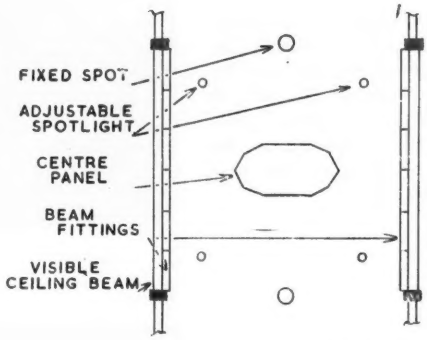
The lighting of modern showrooms always presents a problem in an endeavour to create a special atmosphere, advanced in design, though at the same time remaining simple and unobtrusive; allied to this is the need to keep operating costs down to the lowest possible figure. Flexibility of switching and layout all help to reduce running costs, but the lighting scheme which has to stand on its own to achieve results is likely to be too expensive to run unless the load in the first instance is low. In this store there are two styles of lighting design, that for the ground and second floors being entirely different from that on the first floor and in the restaurant.

Ground Floor

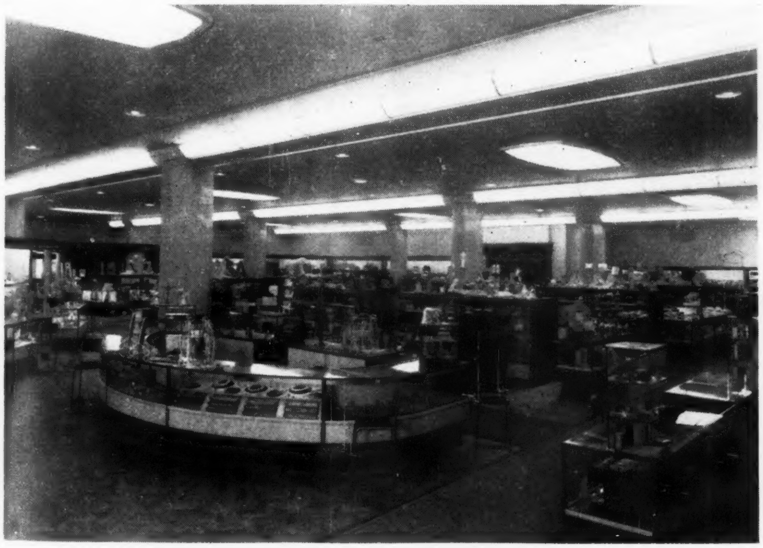
Here it was desired to create a bright clear atmosphere with no suspended fittings to break the line of sight. This floor is 250 ft. long with a ceiling height of 11 ft. 9 ins. The lighting is predominantly fluorescent with tungsten spotlights. The main scheme consists of quadrant-shaped cornice fittings along each side of the main beams, together with large recessed centre panels.

In designing the installation stress has been placed on low costs of cleaning and maintenance. Two types of fluorescent unit are used, both of which are reasonably dust-proof, whilst the spotlights do not need cleaning during life.

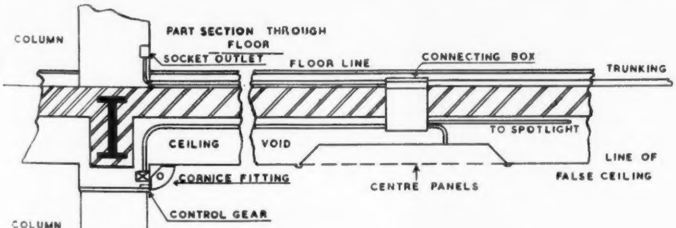
The whole or part of the scheme can be used according to needs, and the cornice units are alternately switched to allow further modification.



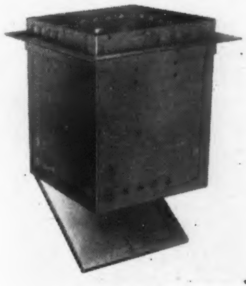
Lighting arrangement for a typical bay.



General view of ground floor.



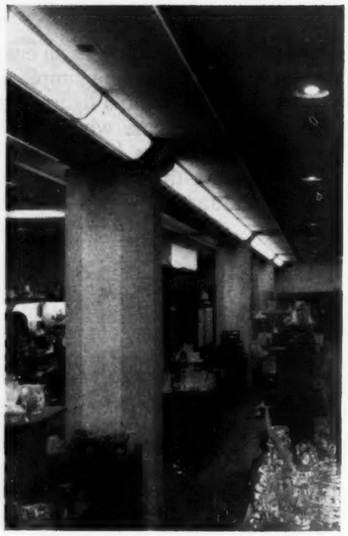
Section of ground floor ceiling.

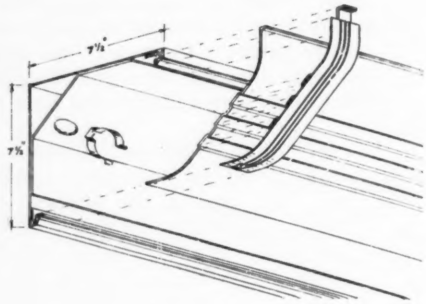


Connecting box.

Cornice Fittings

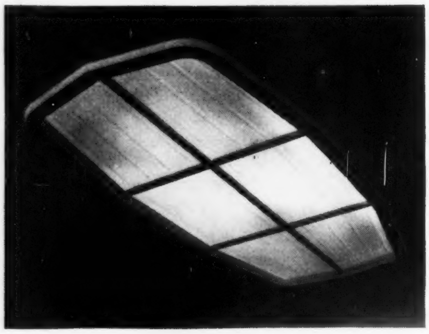
These are fitted into the angle formed by the exposed beam and false ceiling and have a reflector of specular aluminium and a front screen of fluted .040 " Perspex," the control gear being mounted on trays recessed in the beam casing. 5-ft. 80-watt lamps are arranged diagonally and overlap to obviate shadows; for the same reason the B.C. holders are white plastic. Ornamental metal mouldings hold the " Perspex " and at the same time cover the ends of the tubes. Distribution of light is controlled to give a main beam downwards 15 deg. from the vertical and at the same time give ceiling brightness.

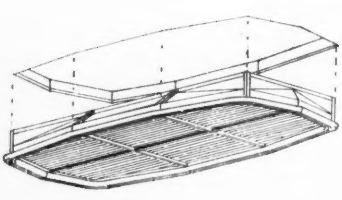




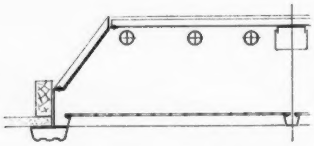
Centre Panels

These are large trough fittings (9 ft. x 4 ft.) recessed in the false ceiling; each houses six 80-watt fluorescent lamps, the control gear being carried inside the fitting. The front screen of .040 fluted " Perspex " is broken up into panels both to improve the appearance and for ease of access.





Isometric.

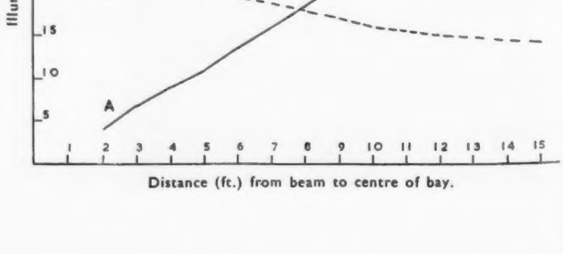


Half-section.

Spotlights

These are of two types—adjustable and fixed. The adjustable spots, which are of the eyeball pattern, use a 75-watt reflector spot-lamp and form a pattern of four in each corner of a bay. One each of the fixed type is spaced between each bay and using the new 100-watt reflector spot-lamp; these are connected to the pilot lighting circuits for after-hour or emergency use and provide sufficient illumination to carry on business should the mains fail.

The adjustable spots are used to increase the illumination on the outer area of the bays.



Light distribution across a typical bay.
A—centre panel only.
B—cornice fitting only.
C—A and B.

Lighting Load

Structural bays of the building are approximately 30 ft. sq.; each bay has 12 cornice beam fittings (six on each side), one large centre panel, four adjustable spotlights and one fixed spotlight.

The total load per bay is 2,200 watts (i.e., 2.44 watts/sq. ft.). The load for the general lighting over the whole floor is 68.2 kw. (of which 56.7 kw. is fluorescent and 11.5 kw. is tungsten) equal to 2.28 watts/sq. ft. over the whole area. Showcase lighting is all fluorescent using the new 5-ft. slimline lamp specially developed for this purpose.

The total installed loads for the whole building are shown in the table.

Lighting Loads and Floor Areas

	Installed Load		Total	Floor Area sq. ft.	Watts per sq. ft.
	Fluorescent	Tungsten			
Basement	—	5,400	5,400	36,840	.15
Ground Floor					
Showroom General	56,700	11,500	68,200	29,820	2.28
,, Showcases	17,600	—	17,600	,,	.59
Non-Selling Area	600	3,070	3,670	5,642	.65
Windows	20,300	30,750	51,050	4,000	12.48
First Floor					
Showroom General	9,700	24,120	33,820	22,065	1.53
,, Showcases	28,720	—	28,720	,,	1.30
Hairdressing	420	8,200	8,620	3,005	2.86
Non-Selling Area	2,000	3,500	5,500	7,356	.75
Second Floor					
Showroom General	24,700	7,025	31,725	19,070	1.66
,, Showcases	6,100	—	6,100	,,	.32
Restaurant	3,450	10,660	14,110	5,080	2.78
Non-Selling Area	—	4,180	4,180	8,315	.5
Public Stairs	2,650	3,860	6,510	—	—
Total Sales Area	167,690	92,255	259,945	83,040	3.13
Total Non-Sales Area	5,250	20,010	25,260	58,154	.43
TOTAL	172,940	112,265	285,205	141,193	2.02

First Floor

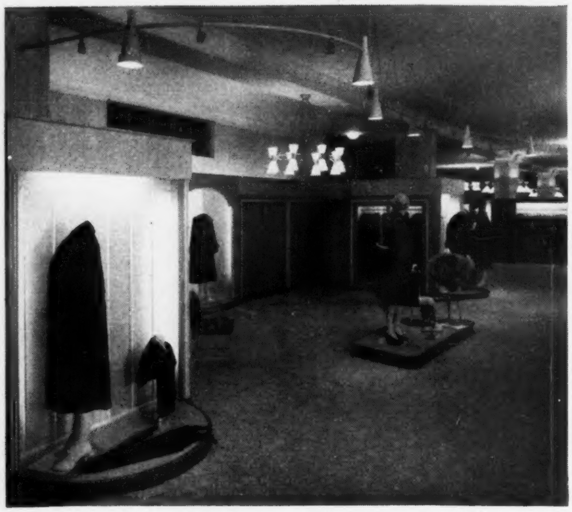
The main first floor showroom area covers some 22,000 sq. ft. and is devoted to fashion goods (frocks, millinery, shoes, etc.). The lighting is almost entirely contemporary in design. Basic lighting is provided by 16 double twin-lamp semi-indirect fluorescent fittings, decorative effect and accent lighting being by tungsten fittings. The latter are of two main types—suspended ring fittings with up-and-down lamps, and suspended bars with lamps in conical shades of different colours, the bars being straight or curved and suspended by either piano wire or thick cords coloured to match the decorations. Around each column are four brackets incorporating up-and-down lamps, the downward part having a silk shade and the upward a metal reflector

General view of first floor.

giving totally indirect lighting. Flush and adjustable spotlights are placed to high-light special features.

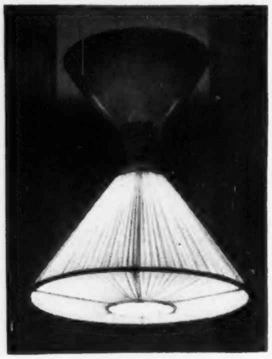
The showcase and fixture lighting is an essential part of the design for this floor; using 5 ft. slimline lamps there is sufficient brightness without glare.

The general effect of the scheme is of a softness of shadows with a contrast of colours from the lighting and the merchandise.



First floor, showing curved suspended fitting.

First floor, showing straight suspended fitting over counter.



Column bracket fitting.

Ladies' Hairdressing

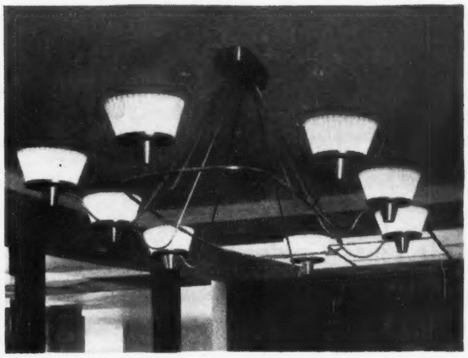
Here again fittings of a modern pattern are used, especially in the open areas. The layout of the department is designed on the modern principle of an area with all the drying units separate from the cubicles. Conical coloured shades, piano wire and thin rods form the basis of most of the fittings.

General view of hairdressing dept.

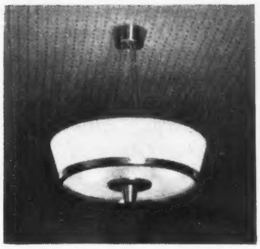
Restaurant

Modern suspended tungsten fittings are used with wall brackets carrying similar shades.

General view of restaurant.



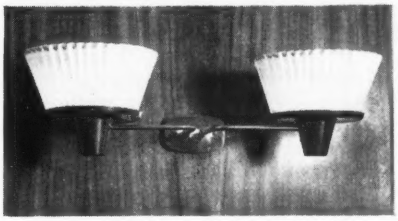
Restaurant entrance fitting.



Small ceiling fitting.

Stairs

There are three public staircases, one in the centre at the rear of the building and two adjacent to the main front entrances. For the latter a wall fitting using the same " Perspex " curve as the ground floor cornice fitting is used in an ornamental housing. For the main stairs the lighting is in two parts. Four 500-watt floodlights in special housings flood downwards from behind the glass of a top laylight. To cut out the shadow of these there are 5 ft. fluorescent lamps in fittings allowing upward and downward light on each half-landing; these units are faced with walnut to match the stairs.



Wall bracket.

Windows

There is 511 ft. of window frontage; the total installed load is 51 kw. or 100 watts per ft. run. The scheme follows standard practice for windows with one viewing position, i.e., a row of two-lamp fluorescent fittings interspaced with 150-watt reflector spot lamps along the front of the window behind the pelmet, with a line of single lamp fluorescent fittings behind a false pelmet 3 ft. from the back of the window. For the entrance and lobby windows industrial fluorescent fittings are installed above eggcrate louvres with eyeball spot-lamp fittings recessed into the louvres. The total floor area of the windows is 4,000 sq. ft. with an average loading of 12.48 watts per sq. ft.

Suppliers of equipment

Lighting fittings :—Ground and second floors and stairs—Allom Bros., Ltd.; first floor and restaurant —Troughton and Young (Lighting), Ltd.; hair-dressing dept.—The General Electric Co., Ltd.; windows—Fredk. Sage and Co., Ltd.

Fluorescent lamps and gear :—The British Thomson-Houston Co., Ltd., and The General Electric Co., Ltd.

Shopfitting and showcase lighting :—George Parnall and Co., Ltd.

Main switchboard :—The Electric Construction Co., Ltd.

Floor control panels :—Walsall Conduits, Ltd.

Cables :—W. T. Henley's Telegraph Works Co., Ltd., and The General Electric Co., Ltd.

Signs :—London Signs and Illuminations, Ltd.

Notes on the City and Guilds Examination Papers

(3) Final Grade. Second Paper

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(1). *Sketch the total radiation spectrum of incandescent carbon, indicating how it alters as the temperature of its surface is raised from 1,000 deg. K to 2,000 deg. K.*

Two sources of this nature radiate uniformly in all directions; source A operates at 1,000 deg. K and source B at 2,000 deg. K and their centres are four metres apart. The amounts of total radiation received per unit area of an exploring surface are equal at a point 250 cm. from A and in the line AB, the sizes of the sources being small compared with these distances. Estimate the corresponding balance point if the temperature of A is raised to 1,500 deg. K, assuming that the ambient temperature is 300 deg. K throughout.

(a) Carbon radiates more nearly as a full radiator (black body) than any other material, and its radiation characteristics may therefore be taken as represented sufficiently closely by the theoretical data for the full radiator. Approximate spectral energy distribution curves for this at temperatures of 1,000 deg. K and 2,000 deg. K are shown in Fig. 5.

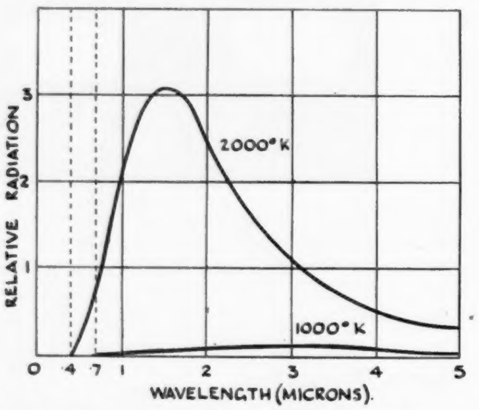

Fig. 5. Approximate spectral energy distribution curves for incandescent carbon.

The total radiation per unit area of surface (i.e., the area under the curve) increases as the fourth power of the absolute temperature (Stefan-Boltzmann law), and the spectral distribution is given by Planck's formula. The value of maximum emission is proportional to the fifth power of the absolute temperature, and occurs at a wave-length inversely proportional to this temperature. As the temperature is raised from 1,000 deg. K to 2,000 deg. K, the proportion of radiation at shorter wave-lengths increases (so that although the radiated power increases some 16 times, the increase of light is much greater—of the order of 1,000 times); the wave-length of maximum emission moves from about 3 microns to about 1.5 microns, and its value is increased some 30 times, whilst the short wave-length limit moves from the red to the blue end of the visible spectrum.

(b) Each source is radiating energy at a rate proportional to the fourth power of its absolute temperature and is absorbing from the surroundings (at temperature 300 deg. K) energy at a rate proportional to $(300)^4$. The power input to the source to maintain its temperature at T deg. K is therefore proportional to (T^4-300^4). If the constant of proportionality is a for source A and b for source B (these factors including the emissivities and sizes of the sources), intensity of uniformly radiating source A is $\frac{a}{4\pi}(1{,}000^4-300^4)$ units, when its temperature is 1,000 deg. K, and is $\frac{a}{4\pi}(1{,}500^4-300^4)$ units when its temperature is 1,500 deg K.

The intensity of B is $\frac{b}{4\pi}(2{,}000^4-300^4)$ units. The radiation falling on the exploring surface from either source is proportional to the intensity and inversely proportional to the square of the distance of the source from the surface. These distances were 250 cm. and 150 cm. for A and B initially, and hence, for balance, $\frac{a}{4\pi}\,\frac{(1{,}000^4-300^4)}{250^2}=\frac{b}{4\pi}\,\frac{(2{,}000^4-300^4)}{(150)^2}$

If the second balance point is at a distance d cm. from A,

$$\frac{a}{4\pi}\,\frac{(1{,}500^4-300^4)}{d^2}=\frac{b}{4\pi}\,\frac{(2{,}000^4-300^4)}{(400-d)^2}.$$

Hence, dividing corresponding sides of these equations,

$$\frac{(1{,}000^4-300^4)}{250^2}\times\frac{d^2}{(1{,}500^4-300^4)}=\frac{(400-d)^2}{(150)^2}.$$

This may be rewritten

$$\left(\frac{10^4-3^4}{15^4-3^4}\right)=\frac{\{5\,(400-d)\}^2}{(3d)^2},$$

whence

$$\frac{5(400-d)}{3d}=\sqrt{\frac{10^4-3^4}{15^4-3^4}}=\sqrt{\frac{9919}{50544}}=0.4430,$$

and $400-d=0.2658d$, or, $1.2658d=400$.

$$\text{Therefore } d=\frac{400}{1.2658}=316.0.$$

The second balance point therefore occurs at a distance of 316 cm. from A.

(*Note*: The effect of the ambient temperature is very slight. If it be neglected, the calculation is simplified, for then $\frac{10^4}{15^4}=\left\{\frac{5(400-d)}{3d}\right\}^2$, whence $d=\frac{6{,}000}{19}=315.79$ cm.)

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Parts (1) and (2) of this series appeared in the July and September issues.

(2). *Write brief explanatory notes regarding four of the following:—*

(*i*) *simultaneous and successive contrast;*
(*ii*) *resolving power of the eye;*
(*iii*) *discomfort and disability glare;*
(*iv*) *Fechner fraction;*
(*v*) *von Kries duplicity theory.*

(i) Simultaneous contrast is the enhancement of apparent difference in luminance or colour which occurs when two surfaces are viewed in close proximity. The stimulation of the retina due to each area affects the adjacent part of the retina, so that its sensitivity to light of the wave-length concerned is reduced. The adjacent surface therefore appears to contain a greater amount of the complementary hue (including black and white as hues).

Successive contrast is a name sometimes applied to the effect produced when the retina is fatigued following strong or continued stimulation by bright or coloured light. The retina gives a lower relative response to subsequent stimulation by light of that wave-length, and the scene appears darker or tinted with the complementary hue. It may be regarded as a form of temporary saturation, which usually does not last long. "After-images" are a local form of this effect.

(ii) The resolving power of the eye is its ability to distinguish fine detail. It is usually measured by the reciprocal of the angle, expressed in minutes of arc, subtended at the eye by the smallest detail of good contrast that can be distinguished. The resolving power increases with the general luminance of the field of view over the range normally met with in practice, and it is greatest when the luminance of the surround is just slightly below that of the task area.

(iii) Glare is the deleterious effect of a bright region in the field of view. In discomfort glare the effect is one of discomfort, although the ability to see may be little affected; in disability glare vision is impaired, although a sensation of discomfort is not necessarily engendered. The amount of glare of either type produced by a given source varies with the general luminance of the field of view, and with the inclination of the direction of the glare source to the line of sight; but whilst disability glare appears to depend only on the total flux entering the eye from the glare source (and not the angle embracing this flux), discomfort glare appears to depend on both the intensity and luminance of the source, and for a constant ratio of source luminance to general field luminance increases as these luminances are raised.

(iv) The minimum luminance difference that can be detected is a function of the level of luminance to which the eye is adapted. Fechner investigated this relationship over the photopic range, and deduced that the threshold luminance difference was a constant fraction of the field luminance, and this fraction now bears his name. However, the actual relationship depends on the conditions of the test, and although the threshold difference is approximately constant at about 1 to 2 per cent. of the field luminance for the photopic range, the ratio increases rapidly with reduction of field luminance in the scotopic range, and the precision of the determination becomes low. It also appears to rise for very high luminance, when glare is probably coming into play.

(v) The von Kries duplicity theory interprets vision in terms of the response of two types of physiological elements in the retina, described as rods and cones, because of their general shape. The rods appear to have a very low threshold of sensitivity to light, and respond rapidly to variation in stimulus, so they are the main means of vision at night, and detect flicker or movements in the field of view. The cones are the elements which distinguish colour, and although their threshold of response is much higher than that of the rods (by the order of 1,000 times), they provide the main response when the luminance level is high, and they can resolve very fine detail. The region of the retina giving most distinct vision, the fovea, consists entirely of cones, whilst the outer part of the retina is formed mainly of rods; the fovea is therefore normally used for photopic vision and the parafovea and periphery for scotopic vision.

(3). *The luminous intensity of a light source with symmetry about a vertical axis varies with angle measured from the downward vertical as follows:—*

Degrees	0	15	30	45	60	75	90
Candelas	600	650	750	800	800	600	0

Four such sources are mounted above a horizontal plane at a common mounting height of 9 ft. and in plan at the corners of a square of 18 ft. side. Determine the ratio of maximum to minimum illumination on the plane within the square.

Determine also, approximately, the proportion of the total light flux from the sources which falls within the square.

(a) The inclinations to the vertical of the light from any fitting to (1) an adjacent corner, (2) the diagonally opposite corner, and (3) the centre of the square, have tangents respectively equal to $\frac{18}{9}$, $\frac{18\sqrt{2}}{9}$ and $\frac{18}{9.\sqrt{2}}$, i.e., 2, $2\sqrt{2}$ and $\sqrt{2}$; they are therefore $63\frac{1}{2}$ deg., $70\frac{1}{2}$ deg. and $54\frac{3}{4}$ deg. respectively.

Since the intensity from each source varies relatively little from 0 to 75 deg., the illumination on the plane from each source will vary approximately as the cube of the cosine of the angle of incidence of the light. As this quantity decreases rapidly for angles greater than about 30 deg., the illumination from the nearest source will generally be the major component of the total illumination at any point. The maximum illumination will therefore probably be close to each corner, and the minimum at the centre of the square. The intensities of a source downwards, towards adjacent and opposite corners and towards the centre of the square, may be estimated as 600 cd., 780 cd., 700 cd. and 810 cd. respectively. Hence, approximately

$$\frac{\text{max. illumination}}{\text{min. illumination}} = \frac{(600\times\cos^3 0\text{deg.})+(2\times780\times\cos^3 63\tfrac{1}{2}\text{deg.})+(700\times\cos^3 70\tfrac{1}{2}\text{deg.})}{4\times810\times\cos^3 54\tfrac{3}{4}\text{ deg.}}$$

Since for any angle θ, $\sec^2\theta = 1 + \tan^2\theta$

$$\frac{\text{max. illumination}}{\text{min. illumination}} = \frac{(600\times1)+(1560/5\sqrt{5})+(700/3^3)}{4(810/3\sqrt{3})}$$

$$= \frac{600 + 62\sqrt{5} + 26}{4\times90\times\sqrt{3}}$$

$$= \frac{600+139+26}{630} = \frac{765}{630}$$

$$= \underline{1.2} \text{ approximately.}$$

(b) For each source, in one quadrant all the light up to $63\frac{1}{2}$ deg. but no light above $70\frac{1}{2}$ deg. falls on the square. Five Russell Angles for the lower hemisphere are given by $\cos^{-1}\frac{2n-1}{10}$ for n having values 5 to 1, viz. $25\frac{3}{4}$ deg., $45\frac{1}{2}$ deg., 60 deg., $72\frac{1}{2}$ deg. and $84\frac{1}{4}$ deg. The intensities at these angles may be estimated as 700 cd., 800 cd., 800 cd., 650 cd.

and 300 cd. respectively. Hence, approximately, proportion of total light flux falling on the square

$$= \frac{\frac{1}{4}(700 + 800 + 800)}{(700 + 800 + 800 + 650 + 300)}$$

$$= \frac{23}{4 \times 32.5} = 0.18 \text{ or } 18 \text{ per cent.}$$

(*Note*: The time required for precise calculations would be very considerable. In the examination, time would necessitate some quick approximation, similar to that indicated above.)

(4). *Describe the construction of one photo-emissive cell and one photo-voltaic cell. In one case give an example of the use of the cell, either in measurement or in some other device, including a circuit diagram and explaining the purpose of any necessary or desirable auxiliaries commonly employed.*

(a) One common form of photo-emissive cell consists of a nickel wire mesh cylinder, which acts as anode, surrounding a rectangular plate, on one surface of which is coated a thin layer of photo-emissive alkali metal, such as potassium on a base of silver oxide, which acts as cathode, the whole being enclosed in an evacuated glass envelope. The leads to the electrodes are sealed into opposite ends of the glass envelope, and an earthed guard ring surrounds the exit of the cathode lead, to prevent leakage current over the glass surface between the electrodes; the whole unit may be electrostatically screened.

(b) The most modern form of photo-voltaic cell consists of a thin layer of selenium (which is the source of electrons), on a steel plate, which acts as positive pole, and covered with a thin transparent, but conducting, film of cadmium oxide (which replaces the very thin film of gold formerly usual) to act as negative pole. A substantial contact ring of metal is sprayed on to the perimeter of the transparent film, which is also protected from damage and moisture by a coating of transparent lacquer, and the whole cell is usually mounted in a convenient holder.

(c) [*Note*: The uses of photoelectric cells are manifold, and the candidate may select any one. Also many alternative circuits have been proposed for each type of cell. (See, for example, Chapter IV of "Photometry," by J. W. T. Walsh, 1953.)]

A common use in lighting is for the measurement of intensity or illumination. The simplest circuit is merely a galvanometer in series with a photo-voltaic cell. If linearity of response is desired, the resistance of the external circuit must be kept low. To vary the sensitivity of the instrument a shunt may be used, or a neutral filter or perforated plate over the photo-cell. To correct for light of different spectral composition, a filter to bring the spectral response of the cell closer to that of the eye may be used, or correction factors may be calculated for specific sources. Several devices have been proposed to correct the response of the cell to obliquely incident light to be more closely in accordance with the cosine law of illumination.

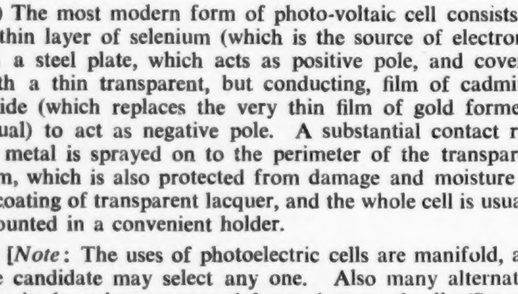


Fig. 6. Diagram for solution of Question No. 5.

(5). *Regarding a fluorescent tube as a perfectly diffusing line source of output 3,000 lumens and length 5 ft., determine from first principles the maximum illumination that can be provided by the tube on a small test plane at a point opposite one end of the tube and 4 ft. from its axis.*

Determine also the angular inclination of the test plane to the tube axis for which this condition obtains.

Let the inclination of the test plane to the tube axis be A deg. For maximum illumination, the normal to the test plane P must obviously lie in the plane of the axis of the fluorescent tube. The intensity per foot length of tube normal to its axis is $\frac{3{,}000}{5\pi^2}$ cd.

Consider a small element of tube S of length δx at distance x from the end X of the tube XY nearer the test plane P, and let angle XPS be ϕ, so that the element S subtends an angle $\delta\phi$ at P. (See Fig. 6.)

Then $x = 4 \tan \phi$, and $\delta x = 4 \sec^2\phi.\ \delta\phi$.

Also $SP = PX \sec \phi = 4/\cos \phi$.

The illumination δE on P due to the element δx is given

$$\text{by } \delta E = \left(\frac{3{,}000}{5\pi^2}\right).\ \delta x.\cos\phi.\ \cos(A-\phi)/SP^2$$

$$= \left(\frac{3{,}000}{5\pi^2}\right).4\sec^2\phi.\ \delta\phi.\ \cos\phi.\ \cos(A-\phi).\left(\frac{\cos\phi}{4}\right)^2$$

$$= \frac{150}{\pi^2}.\ \cos(A-\phi).\ \cos\phi.\ \delta\phi.$$

The total illumination E from the tube XY is therefore given

$$\text{by } E = \frac{150}{\pi^2}.\int_0^B \cos(A-\phi).\ \cos\phi.\ d\phi,$$

where B

$= \text{angle } XPY = \cot^{-1}\frac{4}{5} = 51.35 \text{ deg.} = 0.90 \text{ radian.}$

Thus E

$$= \frac{150}{\pi^2}\int_0^B [\cos A.\cos^2\phi + \sin A.\sin\phi.\cos\phi].d\phi$$

$$= \frac{150}{\pi^2}\left[\cos A.\tfrac{1}{2}(\phi + \sin\phi.\cos\phi)_0^B + \sin A.\ \tfrac{1}{2}(\sin^2\phi)_0^B\right]$$

$$= \frac{75}{\pi^2}[B.\cos A + \sin B.\cos(B-A)].$$

The illumination on P is a maximum when $\frac{dE}{dA} = o$,

i.e., $-B\sin A + \sin B.\sin(B-A) = o$.

Hence, for maximum illumination

$$\frac{B}{\sin B} = \frac{\sin(B-A)}{\sin A} = \sin B.\cot A - \cos B,$$

$$\text{i.e., } \cot A = \frac{B}{\sin^2 B} + \cot B = B(1+\cot^2 B) + \cot B$$

$$= 0.90[1 + (4/5)^2] + (4/5)$$

$$= 1.476 + 0.800 = 2.276.$$

Hence $\underline{A = 23\tfrac{3}{4} \text{ deg.}}$

The maximum value of the illumination

$$= \frac{75}{\pi^2}[0.90 \times \cos 23.75 \text{ deg.} + \sin 51.35 \text{ deg.} \times \cos(51.35 \text{ deg.} - 23.75 \text{ deg.})]$$

$$= \frac{75}{\pi^2}[(0.90 \times 0.915) + (0.781 \times 0.886)]$$

$$= \frac{75 \times 1.515}{\pi^2} = \underline{11.52 \text{ lm/ft}^2}.$$

(*Note*: The above is the full mathematical solution. A quick approximate solution may be obtained by replacing

the tube by a small linear diffusing source at its centre. For maximum illumination the test plane must face this point, and hence A is given by $\tan^{-1}\left(\frac{2.5}{4}\right)$, i.e., 32 deg. The maximum illumination would be approximately

$$\left(\frac{3{,}000}{\pi^2}\right)\frac{\cos 32 \text{ deg.}}{(4^2+2.5^2)}, \text{ i.e., } 11.6 \text{ lm/ft}^2.)$$

(6). *Make a critical comparison of the radiation spectra of a sodium discharge lamp and a high pressure mercury discharge lamp. Exact numerical values are not essential, but the influence of the spectral characteristics on (i) luminous efficiency, (ii) light colour and (iii) suitability for use with fluorescent materials must be clearly explained.*

The radiation from a sodium discharge lamp lying within the visible spectrum is almost entirely in the yellow doublet (at 5,890Å and 5,896Å), although a very small amount occurs in another yellow doublet (at 5,683Å / 5,688Å) and in the red (at 6,160Å), and there is no ultra-violet radiation. Since the strong line occurs close to the wave-length for maximum luminous efficiency of radiation (5,550Å for photopic vision), the luminous efficiency of this source tends to be high, but the light is almost pure yellow and all scenes are rendered in monochrome. Fluorescent materials cannot be made use of because of the absence of ultra-violet and short-wave visible light.

The visible spectrum of the high pressure mercury vapour lamp consists mainly of strong lines in the green (at 5,461Å), yellow (at 5,770Å and 5,791Å) and violet (4,358Å and 4,047Å), with weaker lines in the blue and red, and there is also a continuous spectrum background, the strength of which increases with the pressure of the lamp; in addition there is strong radiation in the long-wave ultra-violet region (mainly at 3,650Å). Because of the yellow and green lines, the luminous efficiency of the lamp is relatively high, and these lines give a greenish colour to the light; the violet light is weak because of its low relative luminous efficiency, but may affect materially the colour-rendering of blue dyes and pigments. However, since there are lines spaced throughout the spectrum as well as the fainter continuous background, most colours can be recognised, although warm colours are considerably distorted because of the shortage of long wavelength radiation. The colour rendering can be improved appreciably with little or no loss of efficiency by the use of fluorescent materials, since the discharge is relatively rich in u.v. radiation.

(7). *A spherical light source of radius 2 mm. centred at P has a uniform luminance of 10 candelas/mm² in all directions. A thin circular disc of radius 5 mm. is placed at Q, 500 cm. from P, and squarely facing it. A concave mirror in the form of a spherical cap, of radius 10 cm., is placed beyond Q and symmetrically aligned with PQ produced, so that a real image of the source is formed on the reverse side of the disc at Q. Determine: (i) the size and shape of the image, (ii) the size of the mirror if the flux falling on the disc is the same on both sides, and (iii) the luminance of the side of the disc facing P. Assume that the mirror surface has a reflection efficiency of 85 per cent. and that the two faces of the disc at Q are perfect diffusing surfaces; secondary reflections may be neglected.*

(i) The light incident on the spherical mirror is substantially parallel, so the image will be formed at its focus, which is at a distance of half the radius, i.e., 5 cm. from the pole of the mirror. The linear dimensions of the image and source are proportional to their distances from the mirror, i.e., 5 : 505. Hence the image formed on Q is a circular disc of radius 0.02 mm. approximately.

(ii) As the light incident on the disc and mirror is substantially parallel, the flux on any portion is approximately proportional to its projected area normal to the rays, i.e., at right angles to PQ.

The side of the disc facing P receives flux direct from the source, whilst the side facing the mirror receives light only after reflection. If there were no losses at reflection, the area of mirror reflecting light on to the disc would equal the area of the disc. Since, however, only a fraction 0.85 of any incident light is reflected by the mirror, the area of mirror receiving light must be (1/0.85) times the area of the disc. Remembering that the disc itself shades from light a central area of the mirror substantially equal to the area of the disc, the total projected area of the mirror must be (1 + 1/0.85) times that of the disc. Hence, if the diameter of the rim of the mirror be D cm.,

$$\pi\left(\frac{D}{2}\right)^2 = (1+1/0.85).\ \pi(0.5)^2, \text{and } D = \sqrt{\frac{1.85}{0.85}} = 1.47_5).$$

The size of the mirror is therefore nearly 1.5 cm. diameter.

(iii) Uniform intensity of source $= (\pi \times 2^2 \times 10) = 40\pi$cd. Hence illumination of surface of disc facing

$$P = \frac{40\pi}{(500)^2} \text{ lm./cm}^2 = 5\times10^{-4}\text{ lm/cm}^2.$$

Assuming the face of the disc to be a perfect diffusing surface, all incident light is reflected diffusely, and hence luminance of side of disc facing P is 5×10^{-4} lambert or 0.5 millilambert.

(8). *Sketch curves showing the response of a normal human eye over the visible spectrum (i) at high intensity and (ii) at low intensity. What explanation would you suggest for any differences between the two conditions?*

Critically consider the visual photometric comparison of light sources of different colours, having regard to these details, and lay down procedures by which any resulting difficulties may be minimised.

(a) *Note*: The curves of relative luminous efficiency of radiation are given in most books on photometry. (See for example Stevens's "Principles of Lighting" Fig. 2.2(a), or Walsh's "Photometry" Fig. 44.) Exact reproduction of the curves is not essential, but the main points to be noted are (i) wave-length of maximum response of the eye is 0.555μ for photopic vision and 0.510μ for scotopic vision, (ii) the limits of the photopic curve are approximately 0.4μ to 0.7μ (although the curve continues at a very low level at least to 0.75μ) and the curve is slightly steeper on the short wave than on the long wave side, and (iii) the scotopic curve is generally similar, but moved about 0.05μ towards the shorter wave-length end (actually rather more for the longer wave-lengths and less for the shorter).

(b) The reason generally accepted for the different spectral response of the eye at high and at low levels of luminance is that the cones are the main perceptors at the high level and the rods at the low level, and these curves represent the different responses of these two elements. (This appears to be supported by the fact that the spectral distribution of the rate of bleaching of visual purple contained in the rods is very similar to the scotopic curve.)

(c) The balance point in the heterochromatic photometric field obviously will tend to be different for a low field brightness than for a high level, since the relative response changes.

However, since there are no rods in the fovea, with a small field (less than 2 deg.) there will be no change in relative response, but the sensitivity at the low brightness is only that of the cones, which drops rapidly and reaches a threshold well above that for the rods. At low levels the eye will therefore tend to fixate away from the fovea, which is disturbing for precise work. There is always the difficulty of allowing for any spatial induction effect of close areas of greatly different colour.

The results obtained in visual photometric comparison of lights of different colours will depend on the characteristics of the observer, the level of field luminosity and the size of field used, as well as the exact method of comparison adopted (e.g., equality of luminance or of contrast of field, or flicker photometer). The flicker photometer is usually found to give most consistent results, but with a colour difference field good results can be obtained by correcting the observations in accordance with the observers' Y/B ratios. In any case, a field of small size (2 deg.) and high luminosity (2.5 ft.-lamberts) should be used. Sources of very different colour may be compared by a cascade method, using sources of less difference in colour as intermediate steps, or carefully calibrated filters may be used to minimise the colour difference. Colorimetric or spectrophotometric methods may be used, but they are elaborate, and rarely necessary. For making comparisons of low luminances of different colour, normal procedure now is to refer both to light of the primary standard source (full radiator at 2,046 deg. K).

New Products

Shop Window Fitting

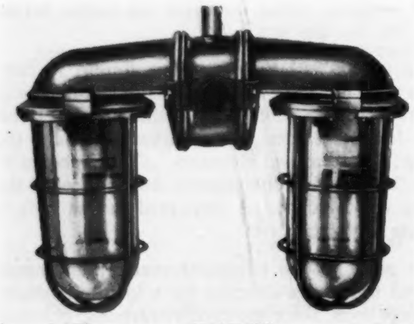
Scemco, Ltd., announce that they have added to their list of fittings, a four-5-ft.-fluorescent-lamp shop-window lighting fitting, the "Windolux," which was previously available only as a "special." The price of the four-lamp fitting is £21; fittings for one, two or three lamps are also available and the range covers 2-ft., 3-ft., 4-ft. and 5-ft. lamps.

"Built-up" Well Glass Fittings

A basic fitting and a number of standard accessories which make it possible for a variety of lighting combinations to be "built-up" are the outstanding features of a new range of 100- and 200-watt lighting fittings now being produced by Victor Products (Wallsend), Ltd. The fittings, which are non-flameproof and watertight, are being produced under patents and licence of Industria, Ltd., Rotterdam.

A corrosion-resisting aluminium alloy is used for all the fittings which incorporate an internal earthing screw. The standard drilling and tapping size is ¾-in. electric thread. Guards are supplied with all fittings and reflectors are available as optional extras. The guards are mounted to the main housing by two captive screws so that when a lamp has to be replaced only these screws need to be removed, and the whole of the underpart of the fitting can then be taken off. Gaskets in the fittings are of heat-resisting rubber designed to withstand all climatic conditions. The junction boxes are drilled and tapped four ways ¾-in. E.T.; the inside diameter of the boxes is approximately 3½ in. Two types of porcelain terminal blocks, four-pole and two-pole, three-way, are also available if required. The well glass is of the clear type with rim, but frosted and tinted glasses can be supplied. Two types of reflector are available—one dispersive and the other concentrating.

Four types of light fittings in the 100-watt range are available. They are the 45-deg. angle and 90-deg. angle well-glass fittings, a pendant fitting and a pendant junction box fitting. There are three types of junction box—a four-way type, with lid, a five-way, including top entry, and a terminal four-way box. One of the most important accessories is a connecting chamber. This is the basic item upon which fittings can be mounted to provide dual combinations of horizontal, 45-deg. angle and 90-deg. angle. In all cases where 90-deg. angle fittings are being used it is not possible to use either reflector. A wall-flange and a wall-mounting cover complete the range of accessories in the 100-watt range. Similar combinations are possible in the 200-watt range.



Victor Products dual 90 deg. "built-up" well glass fitting.

Mercury Fluorescent Lamp

The range of Philips MBF/U mercury fluorescent lamps —already available in 80-, 125-, and 400-watt ratings—is extended by the introduction of their new 250-watt lamp. The outer envelope of the MBF/U lamp is coated internally with a phosphor which converts some of the short-wave radiation into light of a longer wave-length, compensating for the deficiency at the red end of the spectrum, which is apparent in the light from a normal mercury discharge. The lamps have excellent colour rendering properties and are particularly suitable for the lighting of shopping centres, public gardens and amenity centres, and for those areas where a high proportion of female labour is employed. The MBF/U lamp operates from the choke normally used for 250-watt MA/V lamps. In light output a lantern housing a 250-watt MBF/U lamp is roughly equivalent to that of a standard tubular fluorescent lantern housing three 5-ft. 80-watt fluorescent lamps. The 250-watt MBF/U lamp sells at a list price of £6 and is physically interchangeable with standard 250-watt MA/V lamps in existing fittings.

Commercial Vehicle Bulb

Short, robust filaments which will give an improved performance under vibration are fitted to the new Osram 24-volt 6-watt bulb for the side and tail lights of commercial vehicles.

The new bulb, which will supersede the existing Osram 24-volt bulb, is now in production and will be availabe at the same list price of 1s. 6d. It has been developed following intensive field tests on heavy commercial vehicles. Using a double bead construction it has two short 12-volt filaments arranged in series which will withstand greater vibration than the long single 24-volt filament previously employed. (The catalogue numbers remain unchanged; they are No. 149 for a bulb fitted with an S.C.C. cap and No. 150 for a bulb fitted with an S.B.C. cap.)

Louvre Attachments

The Atlas Lighting Division of Thorn Electrical Industries have introduced a new translucent opal plastic louvre attachment for 1½-inch fluorescent tubes. Under the name "Clipluve" it is designed primarily for use with single tube fittings, and may be attached to bare tubes in any fitting to form an attractive, low-priced louvre, eliminating glare and giving a good degree of diffusion without materially affecting efficiency. Moulded in sections 11 inches long, "Clipluve" is packed in cartons containing sets of five to fit a single 5-ft. 80-watt tube. No tools are needed to install "Clipluve." The sections are merely pressed into place against the tube, a simple locking device retaining them securely. These attachments are easily removed and can be cleaned with soap and water.

I.E.S. Activities

VICE-PRESIDENTS: 1955-56

G. E. L. Comrie

Mr. Comrie is well known amongst the Scottish and Northern Centres of the I.E.S. and for many years he has been hon. secretary of the Edinburgh Centre. He has taken a particular interest in the development of centres activities and has regularly represented the Edinburgh Centre on the Centres Joint Committee.

J. W. Howell

Mr. Howell has been one of the most prominent members of the I.E.S. in Yorkshire since he helped to form the Leeds Centre in 1937. He has been very active in publicising the society in the North-east and played a leading part in the formation of other Groups and Centres. He has given lectures in many parts of the country and was chairman of the Leeds Centre in 1950. He is manager of the Lighting Service Bureau in Leeds.

A. G. Penny

Mr. Penny has been a prominent member of the I.E.S. for many years and has served on the Council over a period of many years; he has also been an active member of many committees, notably the Summer Meeting Committee. He has been with the G.E.C., Ltd., since 1928, and his activities with numerous international lighting committees have made him well known overseas. He was elected a vice-president of the I.E.S. in 1954.

R. W. Steel

Mr. Steel is manager of the Bath District of the South-Western Electricity Board. He helped to form the Gloucester and Cheltenham Centre of the society and was chairman in 1946. He was chairman of the Bath and Bristol Centre in 1953. He has been a very active member of the society in the South-west.

J. W. Strange

Dr. Strange is well known for his research work on fluorescent lamps and he has given a number of papers in London and to Centres of the I.E.S. After carrying out research on phosphors for cathode-ray tubes for E.M.I., Ltd., he joined Thorn Electrical Industries in 1941 to start their manufacture of fluorescent lamps. He has served on the I.E.S. Council and is a member of the Papers Committee. He was elected a vice-president of the I.E.S. in 1954.

REGIONAL CHAIRMEN: 1955-56

Bath and Bristol

Mr. J. E. L. West is assistant district commercial officer for the Bath District of the South-Western Electricity Board. He joined the City of Bath Electricity Dept. in 1935 and served in the sales and contracting section of that undertaking until nationalisation. He was a founder member of the original Bath Group which subsequently amalgamated with the Bristol Group.

Birmingham

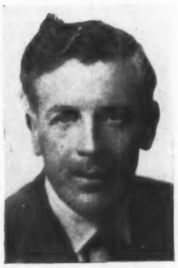
Mr. G. R. Hanson joined the society in Leeds in 1938 and subsequently moved to Newcastle where he served on the Centre Committee and later became hon. secretary. In 1950 he moved to Birmingham where he is Midlands Area Manager for Benjamin Electric, Ltd. He has presented a number of papers on industrial and school lighting. He is on the Register of Lighting Engineers.

Cardiff

Mr. R. D. Jones joined the illuminating engineering dept. of the G.E.C., Ltd., in Cardiff in 1939, but after a short time joined the Army, where he served in the R.E.s. He returned to the G.E.C. in 1946 and the following year went to Benjamin Electric, Ltd., as area sales engineer. Since 1948 he has been senior lighting engineer of the B.T.H. Co., Ltd., in Cardiff.

Edinburgh

Mr. G. E. L. Comrie first became interested in the technical side of lighting in 1935 when he joined Holophane, Ltd., and was later appointed sales engineer for Scotland. He has been responsible for the activities of the Edinburgh Centre for a number of years and has served both as hon. treasurer and as hon. secretary. He is a vice-president of the society for 1955-56.



Glasgow

Mr. C. Stuart, A.M.I.E.E., served an apprenticeship with Wm. Denny and Bros., Ltd., at Dumbarton, and later supervised ship electrical installations. After the war he joined Philips Electrical, Ltd., in Glasgow. In 1950 he took up his present appointment as lighting engineer for the Scottish Area of Ekco-Ensign Electric, Ltd. He is a Registered Lighting Engineer.

Gloucester and Cheltenham

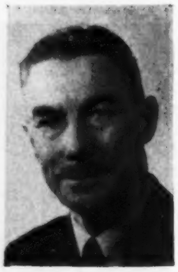
Mr. A. H. Green joined the B.T.H. Co., Ltd., in 1936 and was attached to the Cheltenham Branch. During the war he saw service in North Africa and in Italy and returned to Cheltenham on demobilisation in 1946. He has served on the Centre Committee for a number of years.

Leeds

Mr. R. R. Cooper received his training at the School of Engineering and Navigation in London and with the Stepney Borough Council Electricity Dept. He later served as an electrical engineer officer with the R.A.F. Since the war he has held various appointments with the Ministry of Works, British Railways and the West Riding County Council and is now in the City Engineer's Dept. at Wakefield.

Leicester

Mr. J. L. Walker has been with Cryselco, Ltd., for thirteen years and was that firm's representative in Lincolnshire before taking over the management of the Leicester Branch two years ago.



Liverpool

Mr. G. L. Butler joined the staff of the G.E.C., Ltd., in Manchester in 1912. On his return from the First World War he took charge of the Cable and Conduit Dept. and was later made manager of the Fittings and Lighting Dept. He was appointed assistant manager of the Liverpool Branch of the company in 1931 and has been manager since 1950.

Manchester

Mr. F. Ainscow was educated at Cheetham Central School and the Manchester College of Technology. He is a director of W. H. Smith and Co. (Electrical Engineers), Ltd., and is a past chairman of the Manchester Branch of the E.C.A. and is a member of the national council of the E.C.A. He has been a member of the society since 1933.

Newcastle

Mr. J. N. K. Rankin, A.I.M.E.E., received his training at Queen's University, Belfast, and with the Belfast Corporation Electricity Board. In 1915 he joined the Sunderland Corporation, where he held various appointments concerned with supply and distribution. Before nationalisation he was installation and development engineer and is now District Commercial Officer at Sunderland for the North Eastern Electricity Board.

Nottingham

Mr. P. A. Moore, ASSOC. I.E.E., is chief electrical engineer for E. G. Phillips, Son and Norfolk, consulting engineers, and is particularly interested in electrical services in hospitals and industrial plants. He received his early training with the G.E.C., Ltd., and later with another firm of consulting engineers and he studied at the Wandsworth Technical Institute and at the Battersea Polytechnic.

Sheffield

Mr. W. Berry has been engaged on lighting for over 40 years and has been a member of the society since 1927. After having been engaged on research work and as a designer and estimator for commercial and industrial lighting installations, he joined Holophane, Ltd., as a lighting engineer in 1925 and in 1940 he went to the B.T.H. Co., Ltd., with whom he is still employed.

North Lancs

Mr. H. E. W. Selby received his early training at the Horsham Engineering Works, Sussex. He had many years' experience on installation work, including 10 years with the County of London Electric Supply Co., Ltd. In 1947 he was appointed assistant electrical engineer with the Lancashire County Council specialising in the supervision and safety aspects of low-level lighting installations in places of public entertainment.

I.E.S. Forthcoming Meetings

LONDON

October 11th

Sessional Meeting. Presidential Address. The Society and the Citizen, by A. G. Higgins. (At the Royal Institution, Albemarle Street, W.1.) 6 p.m.

October 25th

Report and Discussion on the 1955 meeting of the International Commission on Illumination. (At the Lighting Service Bureau, 2, Savoy Hill, W.C.2.) 6 p.m.

CENTRES AND GROUPS

October 3rd

LEEDS.—Stage Lighting, by P. Corry. (At the Lecture Theatre of the Yorkshire Electricity Board, Ferensway, Hull.) 7 p.m.

October 5th

EDINBURGH.—Shop and Store Lighting, by R. L. C. Tate. (At the Y.M.C.A. Hall, 14, St. Andrews Street, Edinburgh 2.) 6.15 p.m.

NEWCASTLE.—Chairman's Address, by J. N. K. Rankin. (At the Large Lecture Theatre, Grey Hall, Department of Electrical Engineering, King's College, College Road, Newcastle upon Tyne 1.) 6.15 p.m.

SWANSEA.—Lighting for Sport, by M. W. Peirce. (At the South Wales Electricity Board's Demonstration Theatre, The Kingsway, Swansea.) 6.30 p.m.

October 6th

CARDIFF.—Lighting for Sport, by M. W. Peirce. (At the South Wales Electricity Board's Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

GLASGOW.—The Architect and the New I.E.S. Code, by A. Buchanan Campbell. (At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow C.2.) 6.30 p.m.

LEEDS.—Supper Dance. (At the Astoria Ballroom, Leeds.)

NOTTINGHAM.—Chairman's Address, by P. A. Moore. (At the Demonstration Theatre of the East Midlands Electricity Board, Smithy Row, Nottingham.) 6 p.m.

October 10th

SHEFFIELD.—Chairman's Address, by W. Berry. (At the Medical Library, The University, Western Bank, Sheffield 10.) 6.30 p.m.

October 18th

LIVERPOOL.—Chairman's Address, by G. L. Butler. (At the Liverpool Engineering Society, 9, The Temple, Dale Street, Liverpool.) 6 p.m.

October 19th

GLOUCESTER and CHELTENHAM.—Home Lighting, by Mrs. Jean L. Stewart. (At the Fleece Hotel, Westgate Street, Gloucester.) 6.30 p.m.

NORTH LANCASHIRE.—Members' Night. (At the Demonstration Theatre of the North Western Electricity Board, 19, Friargate, Preston.) 7.15 p.m.

TEES-SIDE.—The Application and Maintenance of Discharge Lamp Installations, by J. J. French. (At the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough.) 6.30 p.m.

October 20th to 22nd

MANCHESTER.—Conversazione on Light. (Manchester Federation of Scientific Societies, College of Technology, Sackville Street.)

October 24th

LEEDS.—Chairman's Address. The Installation, The Engineer and the Local Authority, by R. R. Cooper. (At the E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds 1.) 6.15 p.m.

LEICESTER.—Special Effects for TV Studio Productions, by A. M. Spooner. (At the Demonstration Theatre of the East Midlands Electricity Board, Charles Street, Leicester.) 6 p.m.

October 26th

TRANSVAAL.—Annual General Meeting. (At Room 95, Public Library, Johannesburg.) 8 p.m.

October 28th

BATH and BRISTOL.—Architects' Night. Joint Meeting with the Bristol Society of Architects. (At the Royal Hotel, Bristol.) 7 p.m.

BIRMINGHAM.—Display Lighting, by J. A. Barker. (At Regent House, St. Phillip's Place, Colmore Row, Birmingham.) 6 p.m.

Frontispiece

The frontispiece on page 330 shows the entrance to the new examination halls at Edinburgh University. The lighting of these halls was designed in the initial planning stages by co-operation between the architects (Rowand, Anderson, Kinimonth and Paul), the consulting engineers (Mitchell, Day and Lackie), and the lighting engineers of the G.E.C., Ltd. Tungsten lamps in recessed fittings provide the basis of various ceiling patterns in the different halls. The fittings were designed so that they can be focused and serviced from beneath. It is also possible for rewiring, when necessary, to be carried out from below.

Trade Notes

SCEMCO LTD. announce that early next year their Fluorescent Lamp Division will be moving into larger premises after which their present production of 10,000 lamps per week will be greatly increased. The size of lamps manufactured range from the 12-in. 10 watt to the 5-ft. 80 watt. The 4-ft. and 5-ft. lamps have a rated average life of 5,000 hours. Prices range from 9s. for the 12-in. lamps to 11s. 6d. for the 5-ft. lamps plus P.T. Sample packs for twelve 4-ft. or 5-ft. lamps of mixed colours are available.

The SIEMENS BROTHERS group of companies announce the opening of a new sub-branch at Reading where the products of the group, including lamps, lighting equipment, telephones, cables and telecommunications, are available from Cardiff-road, Reading, Berkshire. The sub-branch manager is Mr. R. A. Hyde (telephone No. Reading 55030).

London Airport

In the article on the new terminal buildings at London Airport, which appeared on pp. 310-314 in our September issue, mention should have been made amongst the suppliers of lighting equipment of the following: Troughton and Young (Lighting), Ltd. (recessed fittings in the ground floor entrance hall, main concourse, main staircase and control room); The General Electric Co., Ltd. (fluorescent fittings and control gear for the main concourse).

International Commission on Illumination

A number of the papers and reports presented at the C.I.E. meeting at Zürich (reported in the September issue) are still available. Copies can be obtained from Mr. L. H. MacDermott, National Physical Laboratory, Teddington, Middlesex. The prices of papers and reports vary according to their length; the average price is 2s. per copy.

POSTSCRIPT By "Lumeritas"

Readers of this journal who also read "Science News"—the quarterly volume published by Penguin Books—will find in the August number (37) an interesting chapter on "Lighting and Work," by J. B. Collins. The concluding section of this chapter deals with future research, and the author suggests that the dynamics of lighting offer a large field for study. "It has been pointed out," he says, "that completely satisfying lighting cannot be achieved by a static arrangement of brightness patterns, but that continual slow variations should be introduced, such as occur during daylight with moving clouds." This was pointed out by H. C. Weston in his paper on "Visual Fatigue," presented to the I.E.S. in 1952 [Trans. I.E.S. (Lond.), **18**, 57, 1953], and it particularly excited the interest of Dr. J. N. Aldington. When Mr. Weston subsequently presented a similar paper to the American I.E.S. in New York, it was this suggestion that artificial lighting needs to be dynamic rather than static that again excited interest, as well as some surprise, since the opposite view was the conventional one [*vide* Illuminating Engineering **49**, 75, 1954]. I mentioned this subject of variability in lighting in my August comments, since when I have come across a reference to another aspect of the matter by an ophthalmologist. In a discussion on illumination in industry at the Oxford Ophthalmological Congress in 1943 Dr. T. H. Whittington said: "At a certain large drapery stores in London daylight lamps were installed because this light was supposed to be better for matching colours. But women workers in these stores complained of getting tired. One of them said she got restless with the *unchanging* light" [Trans. Ophthal. Soc. U.K., **63**, 359, 1944]. It may be asking too much that both the brightness distribution and the colour quality of the light should be automatically changeable so as to gratify our deep-seated love of variety and prevent artificial lighting from boring us, but I am sure that serious consideration should be given to the achievement of "dynamic lighting."

An outstandingly important paper relating to lighting and vision is published in the September issue of the "British Journal of Ophthalmology." The paper is entitled "Measurements of Visual Acuity," and is a description by C. A. P. Foxell and W. R. Stevens of investigations made by them at the G.E.C. Research Laboratories, Wembley, to determine the relation between visual acuity and the luminance of the object of regard under various conditions of surround size and luminance. It is safe to say that not since Lythgoe's classical studies of luminance and visual acuity, which were published in 1932, has any such thorough and significant work been done on this subject as that of Foxell and Stevens. While they have confirmed Lythgoe's findings, their investigations have been extended to cover conditions which Lythgoe did not study, and, as a result, they have made most interesting and important contributions to our knowledge. This is not the place to review their work, but I hope it will be adequately described by the authors themselves in a future issue of this journal, and they did, in fact, describe it briefly at the recent annual meeting of the British Association in Bristol. However, what they did—in briefest summary—was to measure the "growth" of visual acuity with luminance up to a level of 10,000 ft.-lamberts with luminous surrounds of various sizes from 6 deg. to 120 deg. They found that acuity tends to decrease above 1,000 ft.-lamberts and that a large surround is not necessary to obtain high acuity. Thus, there is no case for lighting the whole visual field sufficiently to make its average luminance nearly equal to that of the most important object of regard simply on the ground of acuity of vision, although there are, of course, other reasons for providing good general lighting. The I.E.S. Code illumination scales extend to 1,000 lm/ft^2, but the highest values of the range apply only to dark objects whose luminance will, therefore, be well below the value beyond which visual acuity tends to decrease.

Last month I mentioned that student ophthalmic opticians are now examined in the subject "Illumination." Actually, a two-part paper covering "Industrial Ophthalmic Optics and Illumination" is set in the British Optical Association's Final Examination. The questions set for the most recent examination have just been published, and as they may interest some readers I quote them in full as follows. (i) *Industrial Ophthalmic Optics*: 1. What are the common symptoms of "eye-strain" and what information about his occupation would you seek from a patient complaining of eye-strain? In examining such a patient, to which measures would you pay particular attention and why? Comment briefly on the statement "one-eyed people are more prone to eye-strain than ordinary persons." 2. (a) Careless handling of cathode ray tubes during the assembly of television receivers may cause the tubes to implode; what protection for the eyes of the assemblers would you advise? (b) Discuss the pros and cons of the different types of optical aids which could be used for (i) inspecting small objects on a moving conveyor belt, (ii) fine lathe work, (iii) assembling small parts, using a bench-mounted jig. (c) What do you know of the eye hazards of furnacemen, and by what optical means can these hazards be avoided? 3. Write a short essay (about 200 words) on the role of the industrial ophthalmic optician, indicating what you think should be the scope of his work, in what respects this differs from the general practice of ophthalmic optics and what advantages may be expected from the application of ophthalmic optics in industry. (ii) *Illumination*: 1. A candle flame is glaring but the much more powerful motor-car headlamp beam is not. If each of these statements can be true, in what circumstances (excluding the intervention of any optical or mechanical anti-glare devices) may they be true, and what principle of lighting for the avoidance of glare is suggested by these circumstances? 2. If you were given a room in a factory for practising industrial ophthalmic optics (a) how would you have it lighted, (b) what would you consider to be suitable values of brightness (i.e., luminance) in foot-lamberts for the wall charts and for their background, and why? 3. If you were asked to give an opinion on the suitability and adequacy of the existing lighting for a particular industrial task, (a) what observations would guide you in assessing the visual difficulty of the task, (b) how could you decide whether the existing conditions of lighting were suitable and, if they are not, what changes you should advise?

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